A STUDY OF OUTCOME OF ANTERIOR CRUCIATE LIGAMENT RECONSTRCUTION USING HAMSTRING GRAFT

DISSERTATION SUBMITTED FOR

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CHENNAI, TAMILNADU

CERTIFICATE

*This is to certify that this dissertation entitled "***A STUDY ON OUTCOME OF ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING HAMSTRING GRAFT"** *is the bonafide work done by Dr.KARTHIK.A, Postgraduate in the Department of Orthopaedic Surgery, Madurai Medical College, Madurai*

DEAN

Madurai Medical College

Madurai

CERTIFICATE

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DECLARATION

I, **Dr. KARTHIK.A**, *solemnly declare that the dissertation titled "***A STUDY ON OUTCOME OF ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING HAMSTRING GRAFT",** *has been prepared by me. This is submitted to* **"The Tamil Nadu Dr. M.G.R. Medical University, Chennai,** *in partial fulfillment of the regulations for the award of M S degree branch II Orthopaedics.*

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ABSTRACT

Back ground and objectives:

A wide variety of techniques and graft types are now available for the reconstruction of ACL. The development of new surgical techniques and recent advances in instrumentation has enabled surgeons to achieve better results. However, varying opinion exist among experts with regard to the ideal technique and graft type to be used. Arthroscopic ACL reconstruction using hamstring autograft with fixation in the femoral tunnel using endobutton and in the tibial tunnel with interference screw is a literature proven excellent technique. We have undertaken this study to analyze the functional outcome in our experience with this procedure.

Methods:

This is a prospective study of patients with ACL injury who underwent Arthroscopic ACL reconstruction using hamstring autograft. Postoperatively, all patients were initiated on the same rehabilitation protocol. All patients were followed up for atleast six months period at regular intervals. Lysholm knee scoring was used to functionally assess the patient.

Results:

80% of the patients had good and excellent functional outcome. 67% patients returned to pre-injury level.

Conclusion:

We conclude that the functional outcome of arthroscopic anterior cruciate ligament reconstruction using hamstring autograft is excellent to good (80%). With proper patient selection and physiotherapy protocol, full occupational and recreational activities can be expected for most of the patients within four to six months of the procedure.

CONTENTS

INTRODUCTION

The knee joint is very commonly injured and the Anterior Cruciate Ligament (ACL) is the most commonly injured ligament requiring surgery [1]. The modern high speed vehicular trauma and sporting life style has led to increased ligament injuries of the knee. The ACL forms the pivot in the functional congruence and stability of the knee in association with the other ligaments, capsule, muscles and bone [2, 3].The ACL primarily stabilizes the knee and aids in preventing the knee against anterior translation [4]. It is also important in counteracting rotational and valgus stress. The anterior knee instability due to tear of the ACL is an important clinical problem. The intrinsic repair capacity of ACL is very poor. The patients with knee symptoms of ACL deficiency, must consider ligament reconstruction for stabilizing the knee joint for achieving better function of the knee joint.

Several studies have elaborated successful reconstruction of the ACL using autograft (bone patellar tendon, hamstring tendon, quadriceps tendon) and allograft (patellar tendon, hamstring tendon, tibialis anterior, achilles tendons [5]. To date several different techniques have been described for Anterior Cruciate Ligament Reconstruction (ACLR) from open to arthroscopic technique [6]. The Bone patellar tendon bone (BPTB) graft was the most commonly used graft in ACL reconstruction. However problems due to the extensor mechanism of the knee, motion loss, patella infra, fracture of patella and the persistence of anterior knee pain has made surgeons to think of other graft materials for use in ACLR. The hamstring's graft represent an alternative autograft material that may be used for ACLR without much trouble for extensor mechanism.

In 1954, successful arthroscope was developed and brought many possibilities for treating knee injuries. Since 1982, the ACLR has often been performed arthroscopically [7]. Arthroscopically assisted ACLR has the advantage of being minimally invasive, accurate graft placement, less damage of normal tissue resulting in quicker wound healing and rehabilitation, minimal hospital stay and very less infection rate.

ACLR with Hamstring tendon has become in popular in patients with symptomatic instability and in appropriately chosen patients yields successful results [8]. The cells of a quadrupled hamstring tendon graft probably survive intra articular implantation, but the cells of a BPTB graft do not. The quadrupled hamstring tendon graft is enriched by synovial fluid initially for its nourishment.

There are a wide variety of fixation devices for the quadrupled hamstring tendon graft; however only a few provide better strength and stiffness than interference screw fixation of a BPTB graft at implantation. Aggressive rehabilitation is safe with both types of autograft as long as strong, stiff fixation methods are used. The meta-analysis was performed Biau, et al, in 2007 to provide qualitative data to ascertain whether BPTB or hamstring graft provided superior knee function as determined by final overall IKDC evaluation and return to pre injury level of activity. No difference was found in the patients restoring to full activity after hamstring tendon graft and BPTB graft reconstruction [9].

There is fair evidence that patients reconstructed with hamstring graft report less morbidity than those reconstructed with BPTB graft. The stability improvement with BPTB graft compared with

four strand hamstring graft remains debatable for most patients. Our study is designed for analyzing the outcome of arthroscopic ACLR with hamstring autograft fixed in femoral tunnel using endobutton and in the tibial tunnel using interference screw and additionally anchored with a cancellous screw or suture wheel if necessary.

AIM

To study the outcome of Anterior Cruciate Ligament Reconstruction using Hamstring autograft.

REVIEW OF LITERATURE

Bozzini, in 1806 devised the first endoscope consisting of a bifid tube with illumination provided by the candle. The device was originally used to view the vagina and rectum. In 1876, Max Nitze developed the first modern cystoscope. Incandescent lamp was developed by Sir Thomas Edison in 1880 which proved to be a milestone in the science of endoscopy.

Prof. Kerji Takagi of Tokyo University, in 1918 first applied the principles of endoscopy successfully to knee joint of a cadaver using a cystoscope. Dr. Watanabe released No. 21 arthroscope in 1951 which proved to be the first successful arthroscope.

In 1845, Amedee Bonnet [10, 11] wrote an article on joint disorders causing hemarthrosis, in which the knee injuries were analyzed. He described three significant signs indicating of acute ACL rupture. "In patients who have not suffered a fracture, a snapping noise, haemarthrosis, and loss of function are characteristic of ligamentous injury in the knee". In 1875, Georges K. Noulis [12] describes ACL's role, and elicited the ligament integrity in knee. Noulis performed a test which was identified with the one now known and used as the Lachman test.

Mayo Robson in 1895 demonstrated the first cruciate ligament repair [13] in a 41yr-old miner who injured his due to fall. The two torn crucial ligaments were sutured in position to their

femoral site of attachment. This patient described his knee to be ‘perfectly strong’ and walked and ran without a limp even after six years

F.Lange [14] in 1903 of Germany performed the first ACL replacement, by using the braided silk attached to the semitendinosus as a ligament substitute. This technique didn’t work and was concluded by M.Herz that using of silk was a nice try, but this attempt failed to imitate nature. Ernest W Hey Groves of Bristol in 1917 [15] was the first person who originally described the surgical procedure for anterior cruciate ligament tear. First operation was done using Iliotibial band transplant on an unstable knee.

Willis C. Campbell in 1935 [16] reported the first use of the medial 1/3rd of the patellar tendon from tibial site, the patellar retinaculum, and a portion of the quadriceps tendon. In this technique tibial and femoral tunnels were made. Suturing of the graft to the periosteum at the femoral tunnel was done. Patient was immobilized with a posterior splint for 3 weeks.

Harry B. Macey in 1939 [17] described a technique using the semitendinosus tendon. At the tibial end the tendon was left attached and then passed through the tibial and a femoral tunnel, and sutured to the periosteum. Through an anterior oblique parapatellar incision joint was approached. Tendinous portion of the semitendinosus was only harvested, stopping at the the musculotendinous junction. With the knee in full extension the graft was fixed. For 4 weeks knee immobilization was done and full activity was allowed after 8 weeks.

Kenneth G,Jones in 1963 [18,19] introduced the concept of using a central one-third of patellar tendon graft with an attached patellar bone block. The tendon was left attached to the tibia; there was no tibial tunnel; and because of the shortness of the graft, the author had to drill the femoral

tunnel from the anterior margin of the notch. The ligament was secured to the periosteum at the superolateral exit site on the femur. Jones reported on 11 cases that had been operated on successfully. In the discussion of the article, Don H.O'Donoghue made the point that the femoral tunnel was in the wrong place.

Kurt Franke (Berlin) in 1969 mastered the use of a BPTB graft. The graft was anchored in the tibial plate with a wedge like piece of bone, and a shell-like piece implanted into the femoral condyle. Franke recommended this procedure to be performed as early as possible, before cartilage damage had occurred. In 10% of his patients postoperative pain on knee loading due to cartilage damage was found. This procedure is better avoided in patients above 50 years old.

D.L.MacIntosh, of Toronto, in 1972 described a technique using a fascia lata graft pedicled on the tibia and then passed beneath the lateral collateral ligament, and attached to the intramuscular septum (MacIntosh 1 – the extra articular MacIntosh). In further modification (MacIntosh 2), the graft was brought back intra-articularly and passed into a tibial tunnel. M. Lemaire in 1975 [20] detaile extra articular ligament reconstruction techniques exclusively. For the treatment of medial collateral ligament injuries gracilis was used. Fascia lata was used for the reconstruction of the torn ACL. The rate of good results was 91% in isolated ACL tear patients

D.J.Dandy in 1981 was the first who implanted a ligament substitute reinforced with carbon fibre using an arthroscopic procedure. His results were very poor [21, 22]. The carbon particles were deposited in the synovial membrane and liver, which resulted in nonuse of this technique. Later dacron and Gore-Tex was used as alternatives for performing ACLR with minimal trauma, and

effectively. By the end of 80s, very high rate of synovitis along with rupture of the neoligaments was seen. As a result, this technique of ACLR was abandoned.

In 1982 Clancy and colleagues published a series of 80 ACL reconstructions using medial third portion of patellar tendon by advancing the harvesting of proximal portion of the graft with a block of patellar bone [23]. Later Clancy modified his technique by detaching the distal end of the graft from the tibial tubercle [24]. This Bone-Patellar tendon- Bone autograft was considered the gold standard procedure in 1990s [25].

In 1987, M. Kurusoka [26] explained that the mechanically weak link of the reconstructed graft was because of its fixation. The human cadaver research study clearly proved that 9-mm diameter cancellous screw fixation was very much superior. In few years resorbable screws came into market. These screws are made of resorbable materials such as PLA (polylactic acid) or PGA (polyglycolic acid).

A.B. Lipscomb et al, researched on hamstring tendons for ACL Reconstruction and found that the ultimate strength of quadrupled semitendinosus tendon autograft is 4108N which is thrice the strength of normal ACL, stiffness is 807N/m which is twice that of BPTB autograft, and on cybex machine could not find any differences between normal and ACL Reconstructed knee at 26 months follow up [27].

In 1988, M.J.friedman [28] pioneered the use of 4 stranded hamstring autograft technique. Later in 1993, by R.L.Larson, S.M.Howell [29], Tom Rosenberg [30] and Leo Pinczewski [31, 32, 33,34] used the pes tendons in 3 or 4 strands, with graft placement in a femoral socket.

Pinczewski did an “all-inside” technique, using 8mm round-headed interference screw, known as the RCI screw. Some pioneers started using hamstring tendons, with different kinds of fixation. Tom Rosenberg devised fixation with Endo-Button that was suspended against the lateral aspect of the femoral condyle. G. Barrett used a bone graft, L. Paulos used a polyethylene anchor, S. Howell and E. Wolf-crosspinning, A. Stacheiolin [35] used a resorbable interference screws and L. Johnson [36] used a staple.

Jomha NM & Co-workers did the study on arthroscopic reconstruction of ACL with BPTB auto graft and interference screw fixation in 1999 among 59 patients using central 1/3rd of patellar tendon, the results suggested ACLR stabilizes the knee joint, prevents early onset of osteoarthritis associated with complications like compromises function of extensor apparatus, anterior knee pain and kneeling problems [37]. Leo Chan & Co-workers reconstructed ACL by quadrupled semitendinosus auto graft using endobutton technique for femoral fixation and found less morbidity and low revision rate and good clinical outcome [38].

Chaudhary D & Co-workers performed ACLR with BPTB autograft in 100 cases and concluded the most common complication is anterior knee pain followed by difficulty in restoring full ROM [39]. Wiliams et al, in 2005, analyzed the minimum of two years clinical outcome of ACLR using 4 strand hamstring tendon autograft in patients with torn ACL. Their study concluded that ACLR by using hamstring tendon autograft eliminated anterior tibial subluxation in 89% of patients at the end of 2 year follow up. 11% was the overall failure rate. There was a significant increase in functional knee scores at the time of follow-up, however the results didn’t have correlation with the results of knee arthrometric testing [40].

Goldblatt and others in their meta-analysis of many studies on BPTB autograft and hamstring tendon auto grafts used for ACLR noted that the cases with hamstring tendon autograft had decreased rate of anterior pain and very less loss of knee extension [41].

The BPTB technique is better in terms of laxity and tunnel enlargement. The functional results of the subjective rating of the results by the patient are better with hamstring tendon graft than the BPTB graft. The IKDC score and anterior knee pain favor Semitendinosus Tendon as the graft material of choice [42]. Pinczewski et al., in their 10 year comparative study of ACLR with hamstring tendon and patellar tendon autograft reported that hamstring tendon autograft is better than BPTB autograft when analyzing the postoperative knee stability, Lysholm score and OA changes [43].

Yasuda et al, compared morbidity associated with harvesting hamstring tendons without doing ACLR with another group with ACLR using hamstring tendon graft. 31 cases with ipsilateral hamstring tendon and 34 cases with contralateral hamstring tendon were done. At 1 month follow up ipsilateral group had significant weakness of hamstring power, but by 12months follow up there was no difference. They also observed that healing of tendon graft within the bone tunnel took 12-26weeks [44].

Using of hamstring autograft for ACLR is gaining popularity. The less graft harvest morbidity, very good biomechanical graft properties and excellent fixation of soft tissue grafts are valid reasons for excellent outcomes following ACLR using hamstring tendons [45]. Jung Hwan Lee and coworkers compared the outcomes after ACLR surgery in 338 patients using BPTB autograft, tibialis anterior allograft and hamstring tendon autograft. The comparative parameters

included Lachman test, the ROM, Pivot shift test, IKDC knee scores and 2nd look arthroscopic findings following one year after reconstruction. They concluded that there was better synovial coverage on 2nd look arthroscopy in hamstring tendon autograft group [46]

EMBRYOLOGY

Embroyogenically, development of the knee joint is first detected approximately at 4 weeks. It begins as a concentration of mesenchyme, the so called 'precartilage stage'. Future femur and tibia become recognizable only when an area of mesenchyme between these two precartilage representations rarifies. The formation is rapid, with the appearance of a recognizable knee joint by the sixth week [47].

ACL is seen as a condensation in the blastema at about 6.5 weeks [48]. It begins as a ventral ligament and invaginates during the formation of the intercondylar space. It forms before joint cavitation and remains extra synovial at all times. The fact that cruciate ligament and semilunar cartilage are derived from the same blastema tends to corroborate the theory that these structures function in concert.

ANATOMY

In a normal adult the ACL averages about 4 cm in length and l cm in width. The ACL is a band of dense connective tissue, regularly oriented and connects the femur and tibia. It is attached on the posterior aspect of the medial surface of the lateral femoral condyle superiorly, and in front of and lateral to anterior tibial spine below. The cruciate ligaments are intra articular and extrasynovial [47, 49, 50]. Normal anatomy of the ACL attachments is studied extensively

because of the importance to reestablish the ‘anatomical’ position of the insertion to obtain an isometric position as much as possible during ACLR.

TIBIAL ATTACHMENT [51]

Distally at its attachment on the tibia, ACL passes beneath the transverse meniscal ligament. Few fascicles of ACL blend with the anterior attachment of the lateral meniscus. The tibial attachment is 11 mm wide and 17 mm anteroposteriorly, broader than the femoral attachment. Tibial attachment forms a triangle with the apex directed posteriorly. The ACL courses anteriormedially as it passes from the femur to tibia

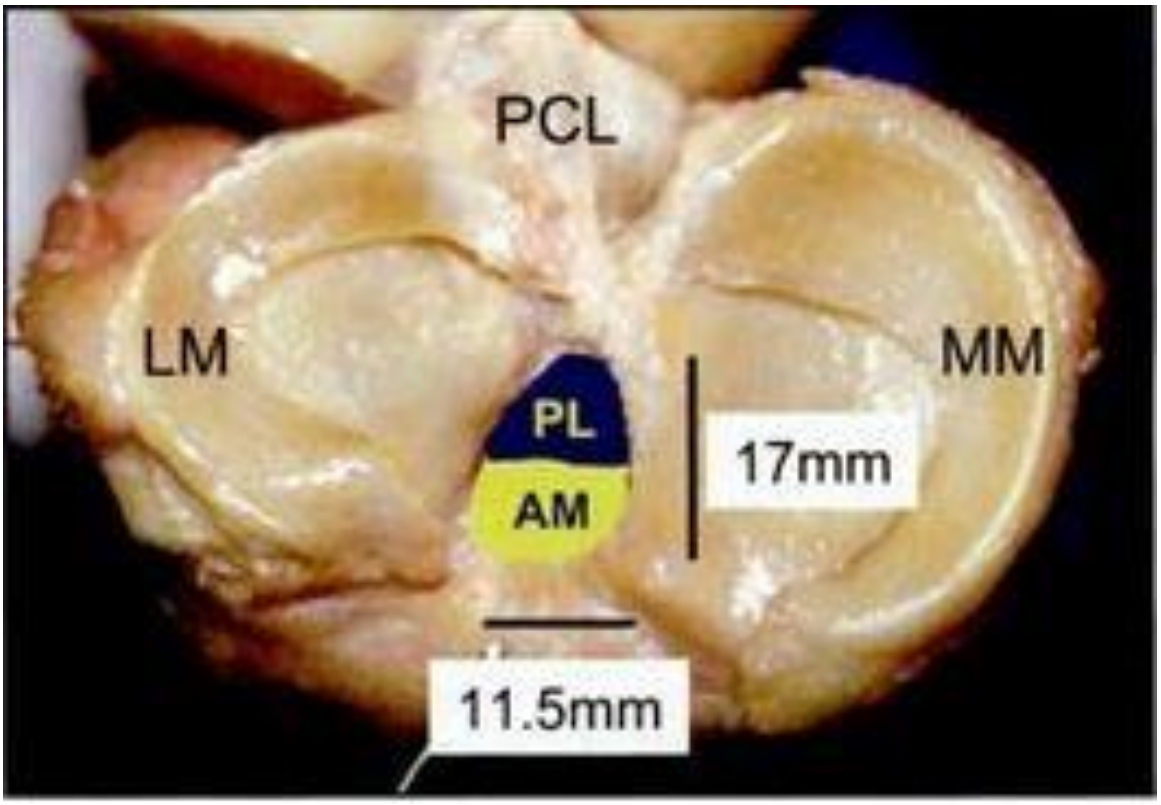


Figure No 1: Tibial attachment of ACL

FEMORAL ATTACHMENT [52, 53]

The ACL is attached on the postero-medial aspect lateral femoral condyle. The attachment has an anteriorly straight border and posteriorly convex border. The long axis of femoral attachment has a forward tilt from the vertical axis. The posterior convexity is parallel to the posterior articular margin of the lateral femoral condyle. The origin is 16-24 mm in diameter. It is located posterior in the intercondylar notch. The centre of this origin is 15mm from the `Over the top position'.

1. **Anteromedial Band (AMB) -** those fascicles originate proximally at the femoral attachment and insert anteromedial aspect of the tibial attachment.

2. **Posterolateral Band (PLB) -** the remaining bulk of fascicles are inserted posterolaterally at tibial attachment. The insertion area of ACL at its insertion site is 3.5 times greater than the mid-substance cross sectional area. This serves to minimize stress on ligament bone interface. The ligament bone attachment is by way of an incorporation of collagen fibers of this bundle within the mineralized bone. This change of ligamentous tissue to rigid bone is mediated through a transition zone of fibro cartilage.

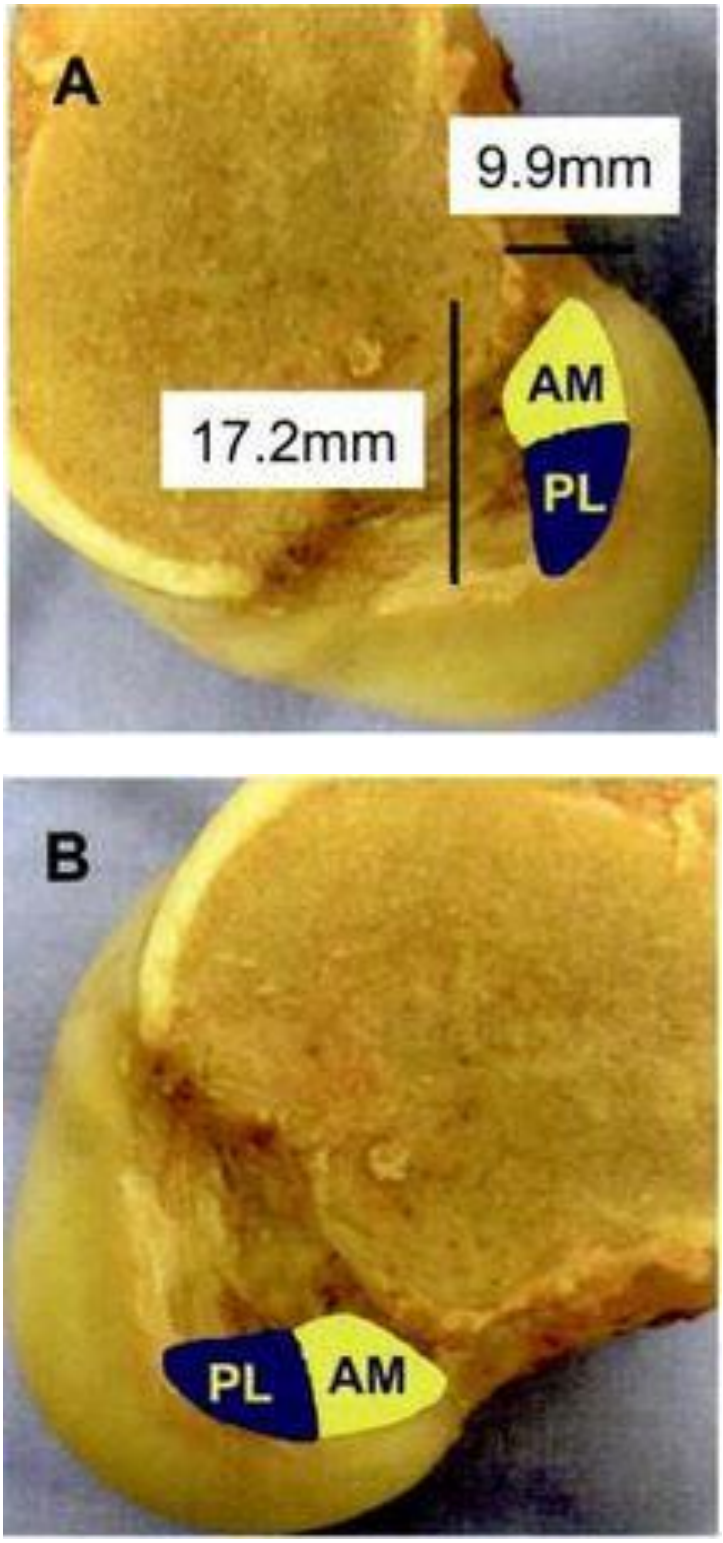


Figure No 2: Femoral attachment of ACL

Orientation of the ACL within the intercondylar fossa [54, 55, 56]

The ACL courses from the femur to the tibia anteriorly, medially and distally, the lengths of the ligament fibres range from 22mm to 41mm with a mean of 32mm; the width ranges from 7mm to 12mm.The location and orientation of its fibres on the femur and tibia determine the external, spiral twist of the composite ligament during its course through the knee. Odensten and Gilquist found no evidence of separation into bundles when transverse sections were examined histologically.

Girgis et al described the two bundles of ACL, the anteromedial band (AMB), and the posterolateral band (PLB). The AMB has been described as the smaller portion of the ligament, whereas the PLB has a larger number of fascicles. The two-bundle description is very well accepted for understanding the mechanical function of the ACL. Amis, Dawkins, Norwood and Cross have divided the ACL into 3 functional bundles (AMB, PLB, intermediate). The length and orientation of the bundles change as the knee passes through motion.

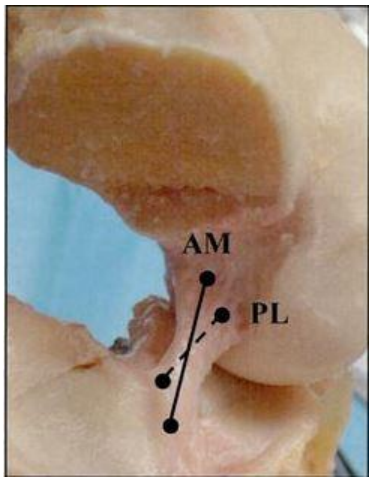


Figure No 3: ACL bundle in intercondylar fossa

HISTOLOGY [57]

The ACL is composed of fibrils of collagen measuring 150-250 nm in diameter that interlace to form complex network. Groups of collagen fibers coalesce to form subfascicles which are surrounded by a thin band of connective tissue of the endotendineum. Each fascicle is surrounded by epitendineum. The whole ligament is surrounded by both paratenon and synovial sheath. An important aspect of the ACL anatomy is the transitional area from flexible, ligamentous tissue to rigid bone, this attachment of the ligament is mediated by a transitional zone of fibrocartilage and mineralized fibrocartilage. The typical architecture consists of four layers – the ligament proper, nonmineralised cartilage zone, mineralized cartilage zone and the subchondral bone plate to which the ligament is attached. This alteration in microstructure allows a graduated change in intrinsic elasticity and also prevents stress concentration functionally at the attachment site.

VASCULAR SUPPLY [58]

The main blood supply for ACL is from the middle genicular artery, which is a branch popliteal artery. The posterior capsule is directly pierced by this branch. Branches enter the synovial membrane at the junction of the joint capsule distal to the infrapatellar fat pad. A few smaller, terminal branches of the lateral inferior geniculate artery may also contribute some vessels to this synovial plexus. The synovial plexus ensheath the entire ligament. Smaller branches penetrate the ligament. These anastomose with a network of endoligamentous vessels which are oriented in a longitudinally and are parallel to the collagen bundles within the ligaments. There is a minimal blood supply from femoral attachment and nothing from tibial attachment.

Nerve supply and neural receptors [59]

Most neural receptors are in the subsynovial layer and near the insertions of the ACL. The posterior articular nerve, a branch of the tibial nerve, is the major neurobundle. The receptors found are primarily Ruffini receptors and free nerve-endings that are thought to function as stretch receptors and nociceptors respectively. In addition to their function as nociceptors, free nerve-endings may serve as effectors by promoting release of neuropeptides with vasoactive function. Thus, they have a modulatory effect in normal tissue homeostasis and also in remodeling of grafts.

FUNCTIONS OF ACL [60, 61]

The ACL functions in concert with all other anatomical structures of the knee joint to control and limit the motion and to enable both static and dynamic equilibrium.

ACL has two complementary roles:

1. Proprioception
2. Mechanical

The evidence of proprioception function comes mostly from histological observations showing proprioceptive nerve endings in the ACL.

The mechanical role as a tensile load carrying element has been characterized with considerable detail.

1. The ACL, principally the anteromedial band accounts for the resistance of anterior tibial translation on femur with the knee in 90 degree flexion.
2. The posterolateral portion provides the principal resistance to hyperextension.

3. It provides a check to internal axial rotation and thereby affords rotatory control of the knee.

4. It is a secondary restraint resisting both valgus, varus strains in all degrees of flexion.

5. Tension in the ACL stabilizes the joint as it approaches terminal extension.

The cruciate ligaments perform the contrasting function of permitting motion of the articular surfaces on one hand and restraining their motion on the other by offering resistance to certain forces. The normal ACL carries loads throughout the entire range of flexion and extension of the knee. The ACL fails differently under different loads, depending on the anatomical position of the joint and the direction in which the forces are applied during injury. The complexity of the ligament fibers and their load responses, have important implications in the results of tensile testing. Tensile testing of the ACL depends on age, angle of knee flexion, direction of tensile force with respect to the ACL, and rate of the applied force. In simple words, the maximal strength of the ACL is not a fixed value.

BIOMECHANICS [62, 63, 64]

Knee joint is subjected to external forces in excess of 5 times the body weight per step.

The normal ROM is from 10degreee of hyperextension to 140 degree of flexion. The stability of the knee joint depends upon the strength of the bones, muscles and ligaments. Quadriceps femoris is the most important muscle in stabilizing the knee joint and ACL is the most important ligament in stabilizing the knee joint.

When the knee comes into fully extension, internal rotation of femur on the tibia occurs until the remaining articular surface of the medial condyle is in contact. When the knee is in flexion the femur externally rotates on the tibia. In extension, the posterior portion of the lateral condyle rotates forward laterally thus producing a “Screw Home mechanism”, locking the knee in fully

extended position. In flexion of knee, AMB tightens and PLB relaxes & with extension of knee, PLB tightens and AMB relaxes *i.e,* during flexion & extension of knee they twist & untwist. The PLB is taut with the knee in full extension and shortens with diminished strain as the knee flexes. Internal rotation is always more than the external rotation.

Under normal condition the anterior translation should not exceed 3 to 5mm. ACL is commonly injured by contact in sports like football, skiing, tennis; road traffic accidents resulting in sudden bending and twisting of the knee or trivial injuries like a slip off while climbing down the stairs. The absence of ACL or ACL deficient knee leads to asynchronicity. This leads to functional instability and unphysiologic loading of the articular cartilage, secondary meniscal tears, subchondral fractures, and ultimately results in accelerated osteoarthritis of the knee joint. The goal of ACLR is to prevent symptomatic instability, restore normal knee kinematics and prevent premature degenerative joint disease.

MECHANISM OF INJURY

As a rule ligament can stretch 10-25% of usual resting length. Ligament injury occurs if the force is sufficient to cause permanent deformation with any mechanism. ACL tear is usually a result of rotational trauma *viz*. flexion-valgus-external rotation, flexion- varus- external rotation, forced external rotation or hyper extension trauma. Rotational trauma usually involve a sudden change of direction and / or with deceleration which may be noncontact injury incurred during sudden change of direction in football or soccer or may be contact injury incurred in road traffic accidents with flexed knees.

If more severe and sudden, ACL injuries may be associated with O'donoghue triad, medial meniscal tears, medial collateral ligament tears. Hyperextension of knee is the less common

pattern of injury of ACL with associated meniscal injuries. However, an ‘adequate trauma’ is not always recognized and some patients may give history of trivial incident like sudden sharp pain in the knee while climbing down the stairs.

CLINICAL EXAMINATION

The clinical evaluation of a patient with suspected ACL injury starts with a good history of the mechanism of injury. A history of twisting injury to the knee i.e. internal rotation of femur on fixed tibia is the most common history. The commonest symptom is giving way of knee which is an expression of the 'axial instability'. Hearing or feeling of a pop is highly suggestive of the injury. Patient will be unable to continue his work or his sport following the injury. The patient complains of severe pain and swelling in the knee. Patient gives a typical history of twisting or hyper extension injury followed by feeling or hearing a pop in the knee at the time of injury and unable to continue the previous activity. Patients with chronic ACL tears, complains of pain, a feeling of instability or both. Patients more likely states that they “can’t trust the knee” or that the knee is “giving away”. Symptoms may occur during normal daily activities or in some patients only during specific movements or during athletic activity.

LACHMAN TEST:

The most sensitive clinical test for ACL injury is the Lachman test. More than 90% of ACL ruptures can be reliably detected with this test. The Lachman test can be performed in acute knee injury. The patient lies supine on the examining table. The involved knee is positioned 20-30 degrees of flexion; the femur is stabilized with one hand, and the proximal tibia is lifted forward to translate it anteriorly. When an anteriorly directed lifting force is applied by the palm and the

fingers, anterior translation of the tibia in relation to the femur can be visualized in ACL tear cases. Anterior translation of the tibia indicates a positive test result and is graded as mentioned below.

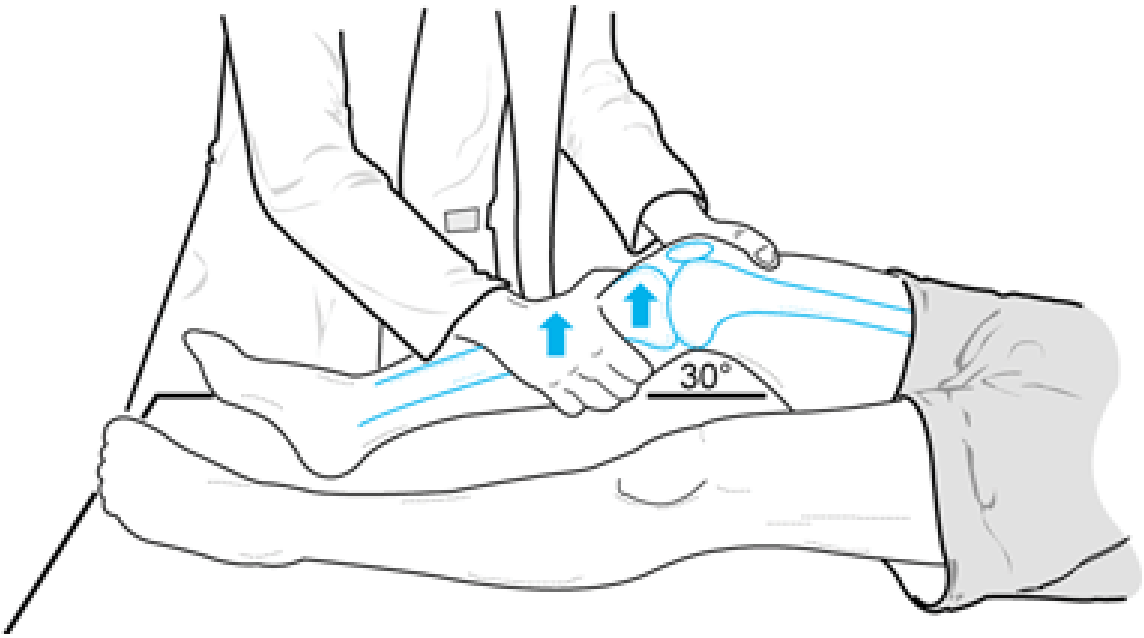


Fig no :4- Lachman test

Anterior tibial translation is graded as follows:

Grade 0 : Normal laxity 0 to 3 mm

Grade 1 : Anterior translation 3 to 5 mms

Grade 2 : Anterior translation 5 to 10 mms

Grade 3 : Anterior translation 10 to 15 mms

Grade 4 : Anterior translation > 15 mms

Lachman test has numerous advantages over other tests. Besides high sensitivity, it can be performed in acute knee injuries with less pain and slight flexion relaxes muscles around the knee.

ANTERIOR DRAWER TEST:

This test is performed with the patient in supine position, hip in 45° and the knee flexed to 90°. The examiner should ensure that the foot points forward without any rotation and the patient is relaxed. It must be made sure that tibia is not sagging posteriorly due to posterior cruciate ligament laxity before anterior drawer stress is applied. In such cases an apparent sign of anterior drawer instability is false positive. The hamstrings can be palpated, allowing the examiner to sense the appropriate relaxation, with the foot stabilized and each hand enveloping the proximal tibia, a forward pull is made. The examiner notes the difference in excursion from one knee to other and the firmness of the end point. Abnormal translation is described in terms of millimeters. Sometimes there is a disparity between the Lachman test and anterior drawer test. This is because of differential injury to the anteromedial and posterolateral bundles of ACL. A negative Lachman test indicates an intact postero lateral bundles and a positive anterior drawer test indicates disrupted antero medial bundles.

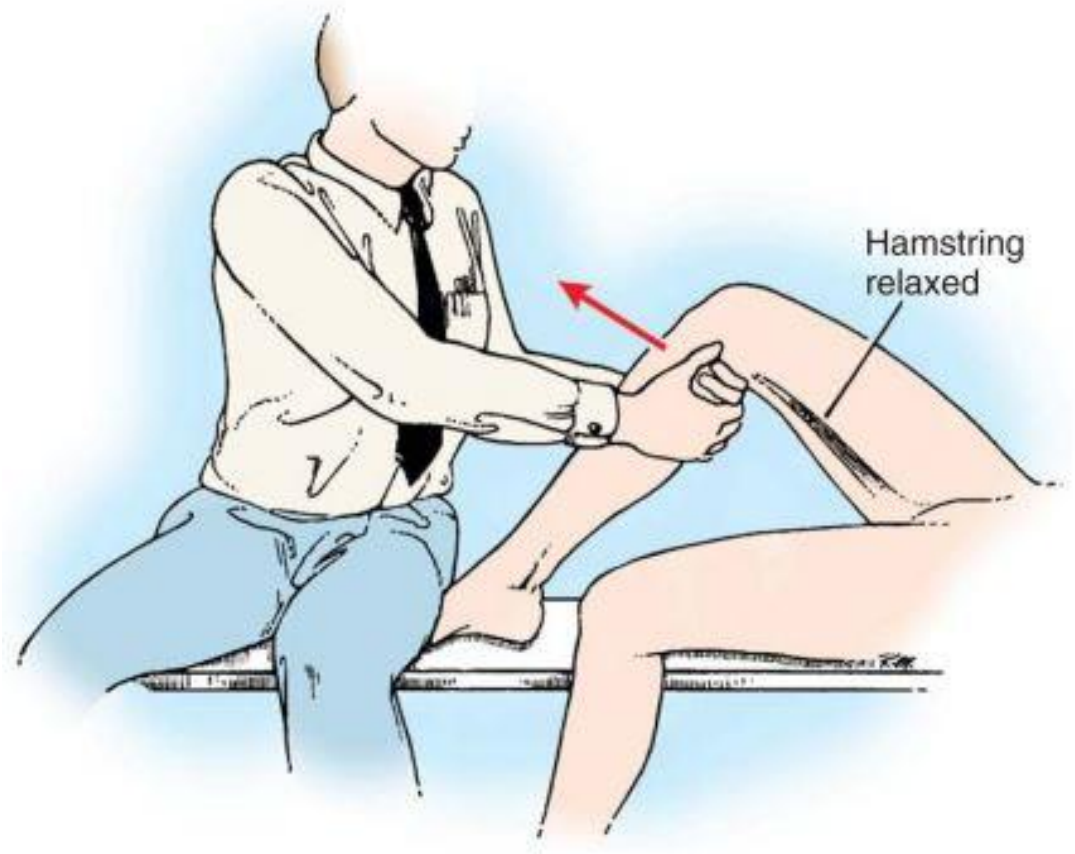


Fig no 5: Anterior Drawer test

PIVOT SHIFT TEST:

The leg is held in a specified position of tibial or foot rotation combined with a valgus stress, and then the knee is forcibly flexed and extended. With the patient laying supine, the examiner first alternatively flexes and extends the knee to allay the patient's anxiety about the test. With the leg abducted at the hip and tibia in neutral or external rotation, the examiner carefully exerts a simultaneous axial and anterior pressure with the hand cradling the lower leg. If ACL tear is present, a gentle subluxation will occur near 20-30degrees of flexion. The pivot-shift test is graded as 0-negative, grade 1 -glide, grade 2 clunk or grade 3 gross. The patient may also feel anterior subluxation of the tibia

Fig No 6: Pivot shift test

The following tests are used in detecting associated injuries:

Valgus stress test:

With knee in 30 degree flexion, abduction/valgus stress is applied to knee joint and laxity observed is due to medial collateral ligament injury. Grading of laxity is based on the amount of opening of the joint (grade 1, 0–5 mm; grade 2, 5–10 mm; and grade 3, 10–15 mm). Valgus stress applied in knee extension resulting in laxity implies posteromedial capsule and medial collateral ligament tear.

Varus stress test:

With knee in 30 degree flexion, adduction/varus stress is applied to knee joint and laxity observed is due to lateral collateral ligament injury. Varus stress applied in knee extension resulting in laxity implies posterolateral capsule and lateral collateral ligament tear.

Recurvatum test:

This test is done by simultaneously lifting each extremity by the great toe and noting the degree of recurvatum and rotation of the tibia that occur on the normal and the abnormal side as the maneuver is performed. This test is positive if recurvatum occurs on abnormal side indicating posterolateral complex injury.

Meniscal tests:

There are several meniscal tests and combination of various meniscal tests is recommended, because no single test is conclusive. The accuracy rate of the tests ranges from 60% to 95%, depending on the clinical experience of the examiner.

McMurray test for medial meniscus: With knee in full flexion followed by external rotation of leg and slow extension of knee is performed. A positive test is a pop or click that can be felt by the examiner when the torn meniscus is trapped between the femoral condyle and tibial plateau. Patient experiences pain over the posteromedial joint line as the knee is gradually extended.

McMurray test for lateral meniscus:

With knee in full flexion followed by internal rotation of leg and slow extension of knee is performed. Pain over lateral joint line with or without click implies lateral meniscus tear.

APLEY'S GRINDING TEST

The patient lies prone on the table. The clinician places his knee on the patient's thigh in order to fix the femur. The knee joint is flexed to the right angle. Now the clinician applies compression and lateral rotation to the leg from the foot i.e. grinding. If the patient complains of pain by the maneuver, there is a tear in the medial menisci. If the patient has pain while the clinician compresses and internally rotates the leg, there is a tear in lateral menisci.

RADIOGRAPHIC SIGNS

SEGOND'S fracture is named from lateral capsular sign in which a fleck of bone is avulsed from the lateral articular surface of the tibia. This presence of notched deficit in the lateral tibial condyle is suggestive of chronic ACL injury. A cortical osseous fragment visualized anterior and superior to the tibial spine on the lateral X-ray indicate avulsion of ACL from its tibial insertion.

CONFORMING RADIOGRAPHIC METHOD

Lateral Anterior Drawer stress test

The patient is placed on table with knee in 90 degree flexion for anterior drawer sign. Lateral radiographs were taken before and after stress was applied. The normal AP laxity of both the tibial condyles had a maximum translation of 5 mm, beyond which it is abnormal.

MRI IN ACL INJURY:

MR imaging offers direct, noninvasive visualization of the knee joint soft tissue structures, improving the preoperative assessment of derangement. Sagittal images are most useful for evaluation of ACL, fiber orientation of the femoral and tibial attachments. Coronal images are useful for evaluation of the collateral ligaments and for assessing the signal characteristics of the ACL within the intercondylar notch.

The ACL appears oriented like a 'hand in pocket coursing superolateral to anterior inferomedial. Axial views are used for assessment of ACL and posterior cruciate ligament in the notch, bone contusion, para articular fluid collections and the joint capsule. T2 weighted water sensitive sequences are the most useful for evaluation of contusions, edema and hemorrhage seen in association with ACL tears.

Normal ACL Appearance on MR imaging:

ACL has "Propeller" or "fanlike" configuration gray, slightly inhomogeneous signal intensity may be seen in the normal ligament and the ligament may not be seen in its entity on a single sagittal slice.

In injured ACL:

In Acute ACL tears - Poor (or) Non visualization of the ACL on sagittal images, an amorphous edematous mass with focally increased Signal on T2 - weighted images, is observed.

In chronic ACL tears:

Although acute tears can accurately be differentiated from intact ligaments, chronic tears may have potentially confusing appearances due to bridging fibrosis, which resembles the normal

ACL. The researchers found that the most useful MR imaging features for diagnosis of an acute ACL tear was edematous soft tissue in the intercondylar notch.

Non-visualization of the ACL was uncommon with chronic tears. The most useful finding in differentiating chronic tears is abnormal course and focal angulation of the ligament without edema. Focal thickening, waviness and indistinct margin are non-specific findings that may be seen with chronically torn or normal ligaments.

MANAGEMENT OF ACL INJURIES

The management goal of ACL tear patient is to prevent recurrent/further knee injury and allowing the patient to return to their desired work and the level of activities. Various factors should be considered in devising a treatment plan. Conservative treatment options for ACL deficiency are still reported with symptomatic instability and with progression of degenerative joint changes.

Obtaining a normal range of motion and regaining strength equal to the non-injured leg are important. Tremendous emphasis has been placed on hamstring strengthening program since hamstrings are protagonists of the ACL.

Various criteria are applied in selecting patients in selecting patients for operative treatment including

- Degree of instability
- Instability related lesions
- Age of the patient
- Level of activity
- Timing of operation

If the patient has a positive Lachman test and a positive pivot shift test that reproduces the subjective feeling of instability, the ACL should be reconstructed. The presence of instability related lesions indicates that the joint is coping poorly with its ACL-deficient status. Without a stabilizing procedure, progression of the instability related lesion is almost inevitable. They should be considered for ACL reconstruction. Young and middle aged active individuals with symptomatic instability and pain and willing to undergo rehabilitation program effectively should be considered for the surgery. Generally it is advisable to reconstruct ACL after 6-8 weeks of injury.

SURGICAL METHODS:

Open surgery may require release of vatus lateralis muscle and lateral dislocation of patella and now it is considered obsolete, having been superseded by arthroscopy. Arthroscopy technique is superior of all as the graft is harvested without opening the joint, bone drilled and reconstruction is performed. It has the advantage of accurate placement of bone tunnels, cosmetic scars and low morbidity. The graft materials available for ACL reconstruction consist of autograts, allografts and synthetic materials. Autograft options available are Patellar tendon; Semitendinosus tendon; semitendinosus-gracilis tendon; Quadriceps tendon; Plantaris tendon and Iliotibial band. Patellar tendon was the most widely used and was considered gold standard. Donor site morbidity is the greatest drawback of this technique, according to various studies and these are very difficult and sometimes impossible to treat. Given the disadvantages of BPTB graft, semitendinosus tendon graft is becoming increasingly important as an alternate graft. The tensile strength of the quadrupled semitendinosus tendon autograft is far superior to BPTB graft.

Tensile strength of grafts

Graft Ultimate tensile load (N) [65, 66]

Graft	Ultimate tensile load
ACL	2160
BPTB graft 10 mm	2367
Single strand Semitendinosus graft	1216
Two strand Semitendinosus graft	2330
Four strand Semitendinosus graft/ Gracilis	4090

Graft fixation

ACLR with hamstring graft gained popularity against BPTB graft inspite of increased laxity because of high graft site morbidity associated with patellar tendon harvest. Other advantages are firstly, quadrupled hamstrings have large cross sectional area than similarly sized patellar tendon grafts because of the rectangular shape of the patellar tendon. More collagen in cross-section makes the graft stronger. Secondly, hamstring grafts need smaller bone tunnels, which heal circumferentially if the traditional interference screw is eliminated.

Different fixation of hamstring autograft has improved the compatibility of this soft tissue graft which mimics the normal ACL. Each of these fixation techniques have advantages and pitfalls. Mechanical fixation methods can be categorized as either direct or indirect. Direct methods use interference screws, spiked washers and staples which compress the graft against the bone surface or the bone tunnel wall. Indirect fixation is seen in cross-pin fixation and endobutton suspend the graft within the bone tunnel.

In general fixation device distant to the joint line such as endobutton fail to reconstruct the complex nature of the native tibial or femoral ACL insertion close to the joint surface. As a result, the strain that is induced during cyclic loading is significantly higher when compared to the normal ACL. This results in longitudinal ('bungee-effect') and transverse ('windshield-wiper-effect') graft motion within the bone tunnel, which in turn leads to bone tunnel dilation and might impair healing of the graft to the bone tunnel.

The metallic interference screw fixation is one of the most common fixation devices which is still used for BPTB and hamstring tendon graft. Metallic screw fixation provides rigid and reliable fixation of the ACL autograft close to the joint line, which reduces graft-tunnel motion and possibly tunnel enlargement. Disadvantages can be laceration of the sutures and the graft. The fixation is much more secure on the tibial side. Among various tibial fixation technique, hybrid fixation in which two different techniques were combined provides better stable fixation and also the strength of a single fixation technique can be increased.

Tunnel positioning and Graft placement

It is clear that a good result cannot be achieved solely by selecting correct graft and applying adequate, stable fixation, but principal reason for graft success is an accurate positioning of the bone tunnels. The success and clinical outcome of ACLR mainly depends on anatomical placement of graft. The most common technical error causing recurrent instability following ACLR is nonanatomical ACL graft placement.

ACLR can be done using transtibial or transportal technique. In the transtibial technique, femoral tunnel is drilled through a tibial tunnel positioned in the posterior half of the native ACL tibial attachment site. Transtibial tunnel technique may result in a vertical ACL graft, which may fail to control motions of internal tibial rotation and anterior tibial translation which happen during the pivot-shift mechanism. The inability of a vertically placed ACL graft to control these combined movements may result in the continued symptoms of instability.

Ideal positioning of the graft placement in the tibial tunnel being 40% to 50% posterior on the tibial plateau in the sagittal plane, the femoral tunnel being > 80% posterior along Blumensaat's line in the sagittal plane, and a graft inclination angle of > 15° in the coronal plane. Anterior placement of the tibial tunnel results in impingement, loss of extension and graft failure. Evidence also exists that anterior placement of the femoral tunnel is detrimental to graft function. Howell and Clark et al, established that tibial tunnels located within 37%-47% were within the impingement free range. Stilubli and Rauschning's et al in their MRI and cadaveric study calculated this value to be 41%. Pretensioning of the graft stretches the collagen fibers to reach its maximum extent and also provides better alignment and tensioning of the tendon sutures. Extensive tensioning may "capture" the joint leading to difficulty in regaining motion or articular degeneration from altered knee joint kinematics.

Tendon Bone Healing

Successful ACLR using hamstring graft necessitates good tendon bone healing inside the tunnel. Graft healing is important for facilitating different phases of postoperative rehabilitation.

Tendon graft to bone tunnel healing can be divided into 4 stages.

1. Inflammatory phase

2. Proliferative phase
3. Matrix synthesis
4. Matrix remodeling

During the inflammatory phase, the infiltration of inflammatory cells and marrow derived stem cells to the interface occurs. Cytokines and growth factors (TGF-beta and PDGF) are released. There is an ingrowth of blood vessels as a result of hypoxia or growth factor stimulation. The stem cells proliferate and differentiate.

In the matrix synthesis phase, MMPs and serine proteases degrade the provisional matrix. The healing cells synthesize and deposit new extracellular matrix with progressive bone ingrowth. During the matrix remodeling phase, the newly-formed bone, interfacial tissue and graft remodel, with establishment of collagen fiber continuity between tendon graft and bone. The cellularity, vascularity and innervation at the interface decrease. The mechanical strength of the tendon-to bone tunnel attachment has been shown to correlate with the amount of osseous ingrowth, mineralization, and maturation of healing tissue.

The pattern of change within the body of autograft tendon when it is transplanted into a human recipient has been described as ‘ligamentisation’. Histologically, predominant fibroblastic ingrowth occurs for the first 2 months, followed by graft remodeling and neovascularity along with areas of necrosis over the next 10 months. Finally, the maturation of the graft over the next two years occurs. The transplanted graft has been found to undergo a process of complete metaplasia to a ligamentous structure within three years of implantation.

Cyclops lesion

It is a natural fibroproliferative tissue originating by accumulation either from drilling debris from the tibial tunnel or from remnants of the ACL stump and, more rarely, from broken graft fibers**.** The cyclops lesion sits in the anterior margin of the intercondylar notch, just above the tibial tunnel, which can become impinged between the tibia and femur upon knee extension. This lesion limits knee extension after ACLR. MRI is a very good diagnostic tool for such lesions. Arthroscopic debridement gives very good results for Cyclops lesions

PRINCIPLES OF SUCCESSFUL ARTHROSCOPIC ACL RECONSTRUCTION

1. Small incision without disturbing uninvolved anatomic structures
2. Visual enhancement and magnification of the intra articular structures
3. Evaluation and documentation of the extent of knee pathology under anaesthesia before surgical intervention
4. Treatment of associated intra articular pathology
5. Debridement of the intercondylar notch and ligament insertion sites
6. Precise selection and placement of the osseous tunnel locations
7. Harvesting the cruciate substitute with minimal donor site morbidity
8. Tensioning and fixation of cruciate graft
9. Early postoperative mobilization and rehabilitation

The only absolute contraindication for ACL reconstruction seems to be performing a procedure in a clinical setting of acute sepsis and in a patient who has a total lack of understanding of the rehabilitation.

Patient Selection:

A specific indication for surgical treatment of the ACL deficient knee remains a debated topic. However each knee must be assessed and treatment must be based on the patient's activity level and expectation. Level of activity profiling: the patient's need and expectations are an important part of the decision making process. If the patient wishes to regain the best knee possible for an active lifestyle, reconstruction of the injured ACL is necessary.

MATERIALS AND METHODS

MATERIAL

The prospective study consists of 15 patients who had undergone Arthroscopic ACL reconstruction using Hamstring autograft at the Department of Orthopaedics &Traumatology, Government Rajaji Hospital, Madurai.

PERIOD OF STUDY

Oct 2012- Sep 2014

Age and sex criteria:

20-50 years of both sex

INCLUSION CRITERIA

- ACL tear diagnosed clinically and by MRI
- Willingness to participate and follow up
- Normal contralateral knee

EXCLUSION CRITERIA

- Revision ACL reconstruction
- ACL injuries with associated intra articular fractures
- previous knee surgery
- Anterior cruciate ligament tear with posterior cruciate ligament, collateral ligament requiring surgery, posterolateral complex injuries

- Osteoarthritis of knee

Preoperative Assessment

Blood investigations

- Hemoglobin
- TC, DC, ESR
- Random blood sugar, Urea, Cretinine
- ECG

Knee X rays- AP and Lateral view

Knee MRI

Implants Required

Endobutton with loop- 15, 20, 25 mm

Interference screws- 7, 8, 9, 10* 25mm

INSTRUMENTATION

Specialized instruments are required for arthroscopic ACL reconstruction. The fluid medium used is Normal Saline and 3 litres bottles are used for the purpose as it exerts more pressure and also does not need frequent changing.

The instrumentation needed is:

1. TV/Monitor
2. Arthroscopy Camera system
3. Light source
4. Shaver System
5. Knee Arthroscopic Instruments

   Trocar, Cannula, 4mm *30 degree arthroscope, probe, hand instruments

6. ACL Reconstruction Instruments

   Tibial Guide, Guide Wire, Reamers, Graft Sizer, Femoral Aimer, Beath Pin, Notch Curette, 4.5mm drill bit

7. Pneumatic Tourniquet

Surgical technique

Initial arthroscopy

The patient is given IV antibiotics preoperatively. After spinal anesthesia, the patient is positioned supine and a tourniquet applied on the upper thigh of the operative leg.
An examination under anesthesia is performed. Diagnostic arthroscopy is performed through an anteromedial and anterolateral portals, and meniscal lesions if present are addressed first.

Graft harvest and preparation

Make a 3 - 4 cm incision anteromedial on the tibia starting 4 cm distal to the joint line and 3 cm medial to the tibial tuberosity. The pes anserinus insertion is exposed with subcutaneous dissection. The borders of the Sartorius tendon is palpated, and identify the semitendinosus and gracilis tendon 3 to 4cm medial to the tendinous insertion. Short incision is made in line with the upper border of the gracilis tendon .Care taken to avoid injury to the underlying medial collateral ligament. With the pes retracted medially, the gracilis and semitendinosus tendons are visible on the medial side. The gracilis is more proximal and thicker and inferior to it is the more horizontal semitendinosus tendon.

After the tendons have been positively identified, the semitendinosus tendon is pulled forward with a curved artery clamp and is released from its tibial insertion including the periosteum. All

sides of the tendon are palpated to confirm there are no fibrous extensions before releasing it with open tendon stripper. Accessory insertions and fascial bands known as vincula have to be released before the tendon is stripped. The vincula is seen approximately 10 cm proximal to insertion of hamstring. If vincula is not released properly then this may end up in premature tendon amputation and short graft. Applying controlled tension on the tendon, advance the stripper proximally and the muscle should slide off the tendon easily. Similarly the gracilis tendon is stripped.

The harvested tendons are debrided from muscle tissue. Each tendon is doubled to create a total of 4 strands, looped with endobutton and running interlocking whipstitch sutures with No 2 ethibond is done. The graft is sized with the help of a sizer. This prepared graft is placed under tension covered by a wet saline gauze.

Tibial and femoral tunnel preparation

When placing the tibial guide, be aware of the intended tunnel length and direction so that the graft can be secured in a physiometric, impingement free position. The inner edge of the anterior horn of the lateral meniscus, ACL stump, 7 mm anterior to PCL and the medial tibial spine are used as intraarticular reference points. The reamer's diameter used for the tibial tunnel is determined by graft sizing. . The cannulated reamer of the appropriate diameter is advanced over the guide pin to make tibial tunnel.

The femoral tunnel is drilled through the transtibial approach. The knee is flexed to > 90°. The 'Femoral Aimer' is brought through the tibial tunnel and with over the top positioning to maintain

the posterior cortical wall to 2 mm. The guide pin is positioned at 10’ clock - 11'O clock for the right knee and 1'0 clock to 2'0 clock for the left knee. The 'Beath Pin' is drilled through the femoral aimer and exits at the anterolateral aspect of the thigh. The femoral tunnel is drilled over the Beath pin with appropriate size reamer upto 35-40mm in length. The roof of the tunnel is further drilled with 4.5 mm drill bit until it pierces and exits the lateral femur cortex.

Graft passage and fixation

The pre tensioned graft with endobutton and its threads are passed through the beath pin tibial end loop and is pulled out of the femoral tunnel, so that the endobutton thread is out of the thigh. Under arthroscopic visualization in the joint, the threads of the endobutton is pulled using the principle of flipping the endobutton. The femoral fixation is confirmed by dancing movement of the endobutton. 15 to 20 cycles of complete flexion and extension of the knee joint is done to tension the graft before fixation. The tibial side of the graft is fixed with an interference screw. Additional fixation using an anchoring 4.5 cancellous screw with washer or suture disc at tibial end is done if necessary. Excess graft at tibial end is cut.

Wound Closure

Thorough lavage of the joint is done to clear off the debris. Romovac size no 12 drain kept in position. Graft harvest site is sutured in layers with no1-0 vicryl. Skin sutured with silk / skin staples. Compression bandage dressing done and long knee extension brace is applied.

Surgical Technique

Fig no 7: Skin Incision

Fig No 8: Identification of Semitendinosus and Gracilis tendon

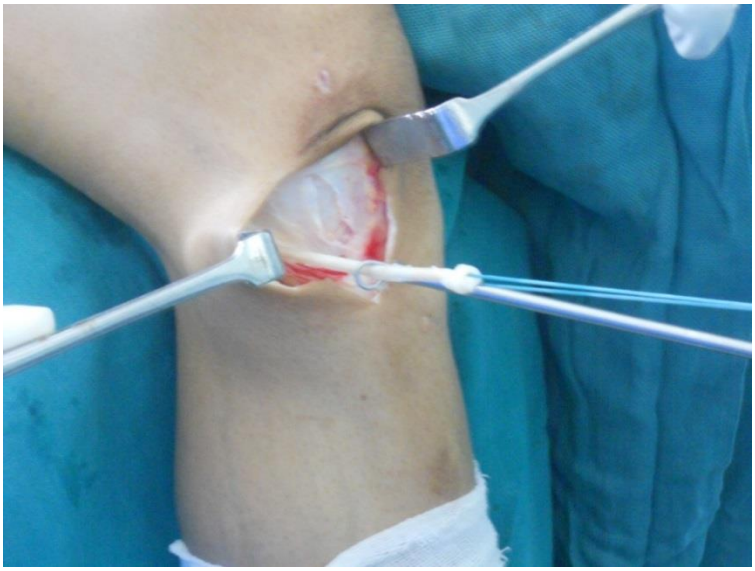


Fig No 9: Stripping of Semitendinosus tendon

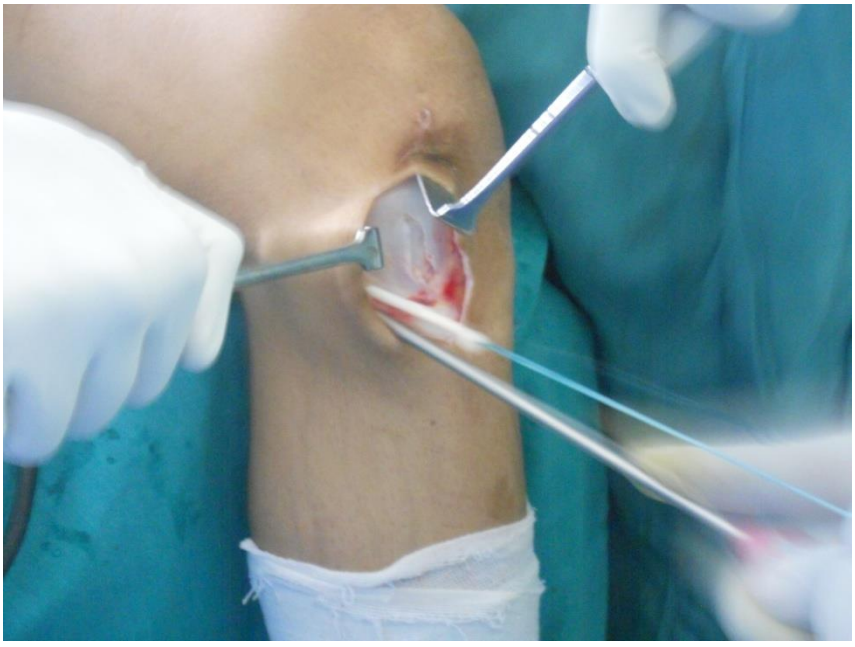


Fig No 10: Stripping of Gracilis tendon

Fig No 11: Tendons after debridement

Fig No 12: Quadrupled graft looped with Endobutton

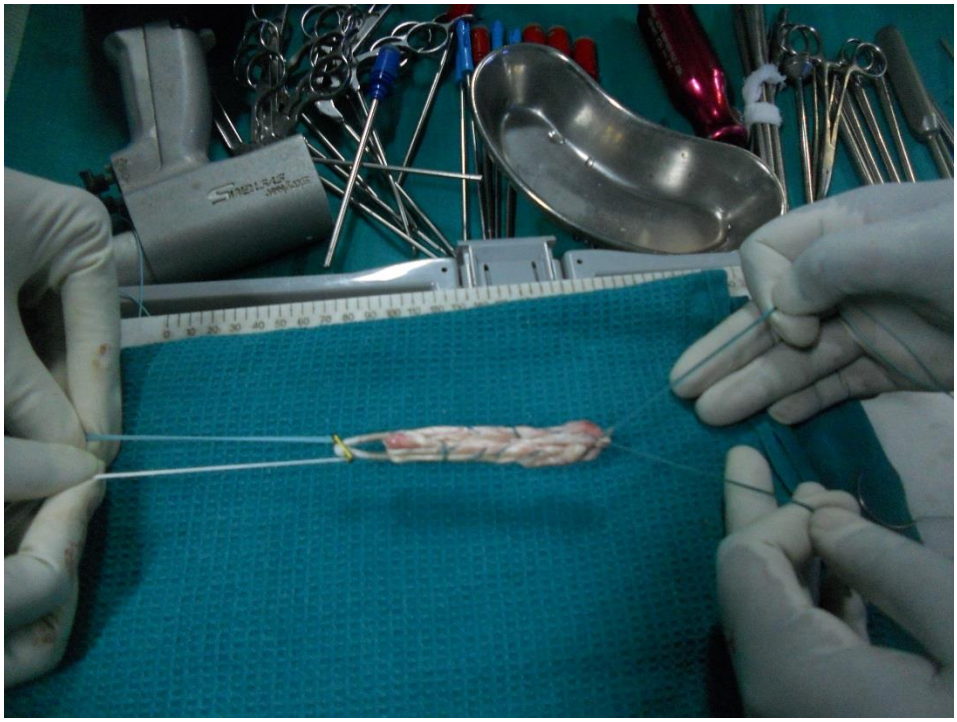


Fig No 13: Quadrupled graft sutured with Ethibond No 2

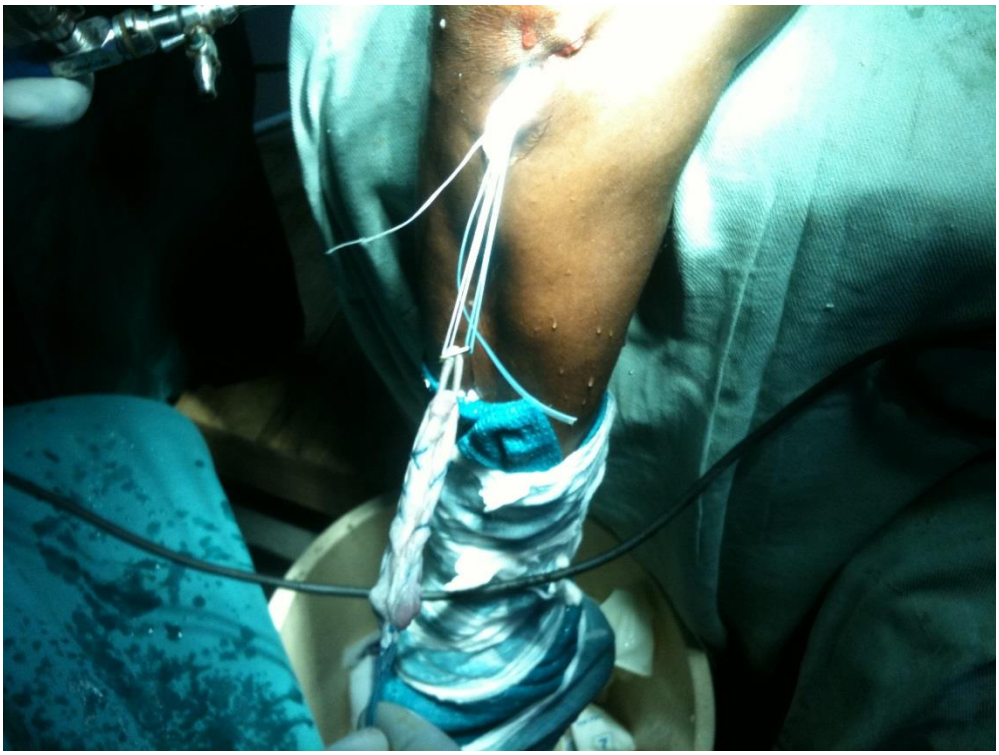


Fig No 14: Graft passed transtibially

Fig no 15: arthroscopic view of graft being passed into femoral tunnel

Fig no 16: Interference screw fixation at tibial end

Postoperative management

All patients were initiated on postoperative ACL rehabilitation protocol on postoperative day 1. Drain removal after 48 hours. Suture removal on 12-14th day.

EVALUATION:

Postoperative X rays - AP and Lateral views were taken on the operated knee. The tunnel positioning and screw placement were analyzed. All patients were reviewed periodically at 6 weeks, 3 months, 6 months and 1 year for assessment. Clinically Lachman test, anterior drawer test and pivot shift test was performed. Range of movements of the operated knee clinically examined. Patients subjected to Lysholm knee scoring scale questionnaire.

The Lysholm Knee Scoring Scale comprised of eight parameters for evaluation. The parameters evaluated are– limp, use of support on walking, locking episodes, instability, pain, swelling, stair climbing and squatting. The individual parameters were allotted specific scores depending on the functional ability of the patient. The maximum possible knee score was 100 points. Based on the outcome scores they were divided into Excellent, Good, Fair and Poor.

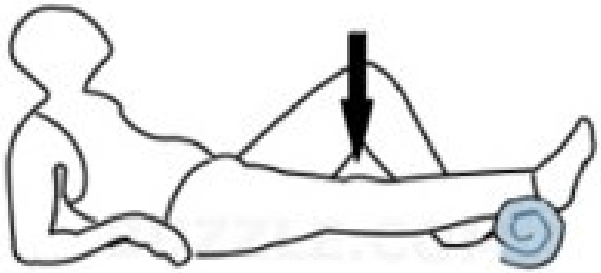
Excellent	95 – 100 points
Good	84 – 94 points
Fair	65 – 83 points
Poor	64 or fewer points

Postoperative ACL Rehabilitation protocol

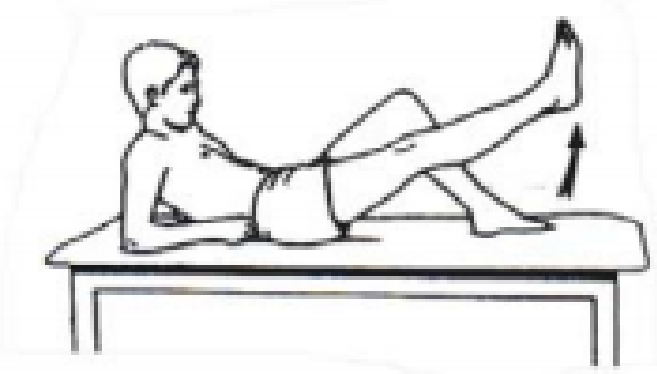
Phase 1: 1 to 2 weeks

Ankle toe movements-

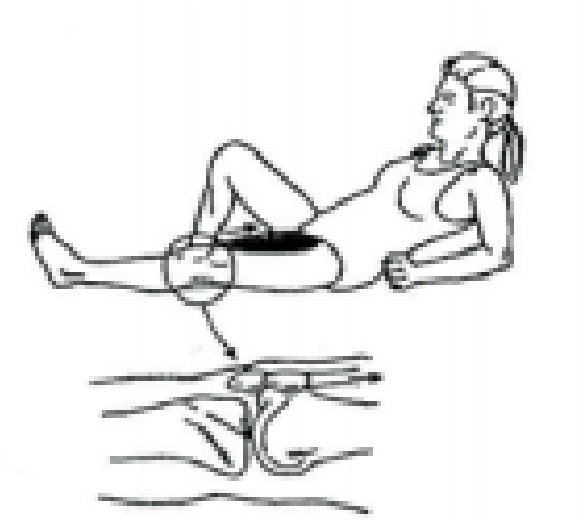
Heel press: keep a pillow under the heel and press the heel, hold for 5 seconds and relax



Straight leg raising with brace on



Static quadriceps



Knee bending- with support

Walking with crutch- partial weight bearing with brace on

Phase 2: 3 to 4 weeks

Continue above exercises

Knee bending- assisted

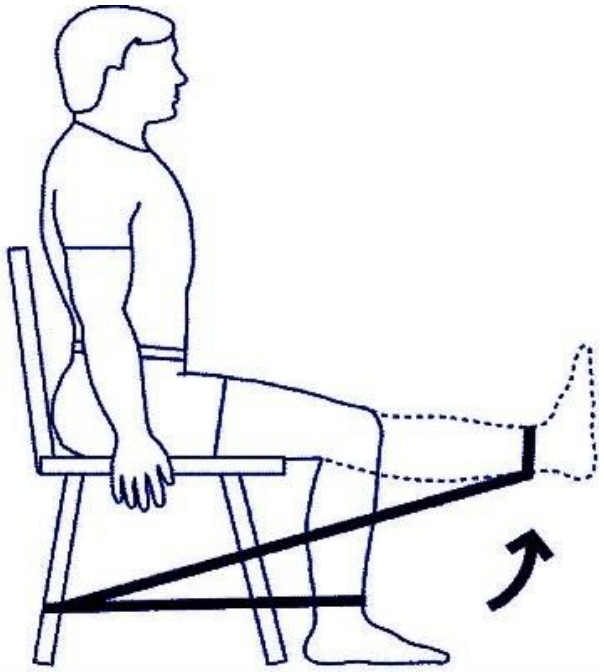
Walk full weight bearing with crutch and brace

Compulsorily wear brace during sleep

Phase 3: After 4 weeks to 3 months

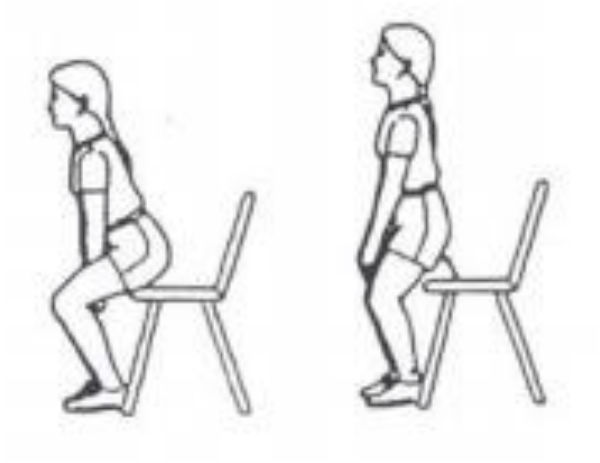
Continue the above

Knee bending- active



Static cycling

Start half squats- 10 repititions * 3 sets twice daily



Remove brace and full weight bearing

Phase 4: After 3 months

Slow jogging for 50-100 meters

Can start swimming

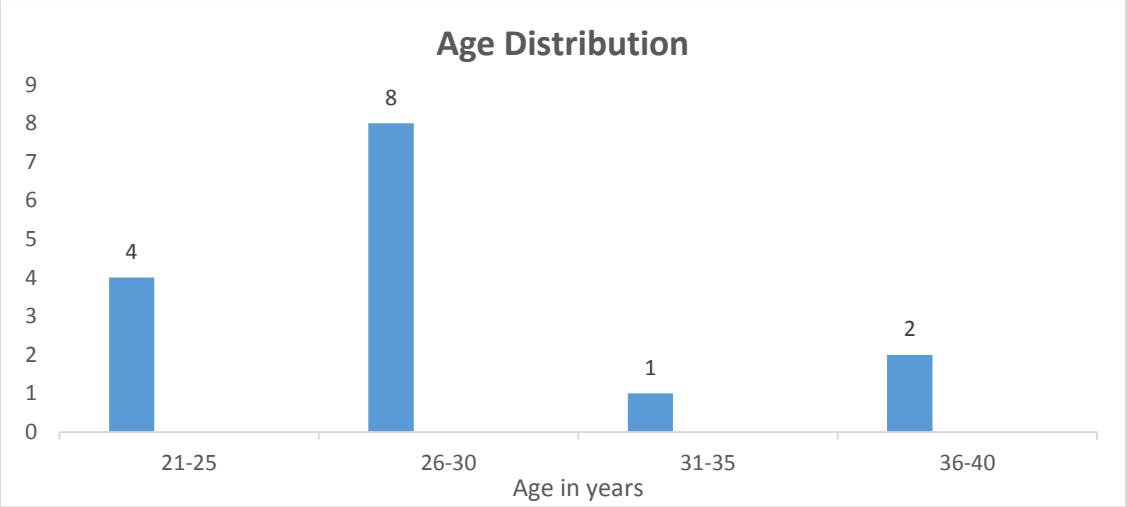
Avoid the following

1. Avoid squatting on the floor, full squats, cross leg sitting and using indian toilet following surgery for 6 months to 1 year.
2. Avoid 2 wheeler driving for 3 months.
3. Do not do full knee bending like normal leg for 1 year

Results

Distribution of cases based on Age

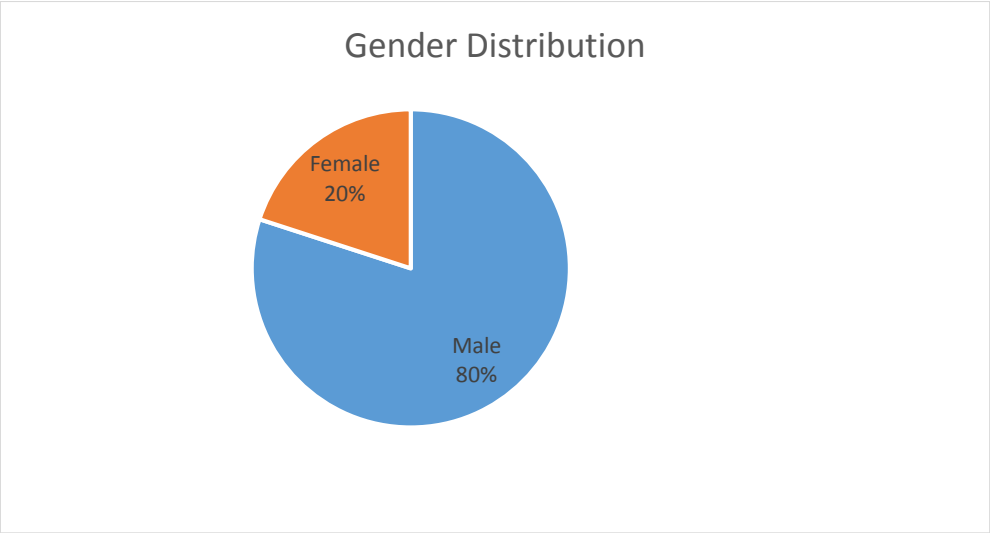
Age in years	Number	Percentage
21-25	4	27
26-30	8	53
31-35	1	7
36-40	2	13
Total	15	100



The mean age in our study was 29.2years. The youngest patient was 22yrs and the oldest patient was 40 years old. The maximum number of patients were in the age group of 26-30yrs (53%) followed by the age group 21-25yrs (27%).

Distribution of cases based on sex

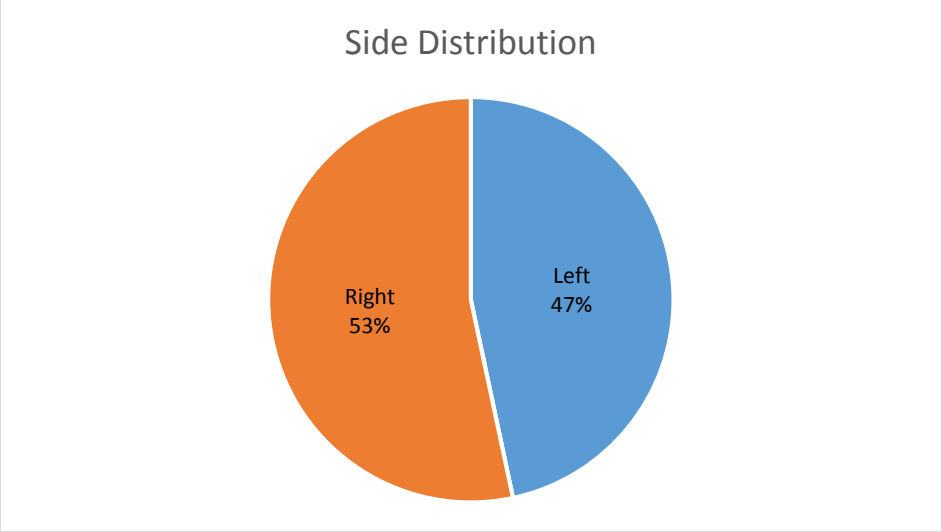
	Frequency	Percent
Male	12	80
Female	3	20
Total	15	100



In our series of 15 patients, 12 patients (80%) were males and 3 patient (20%) female, (Male Predominance). It may be because of the involvement of males in outdoor activities like sports and road traffic accidents.

Distribution of cases based on side

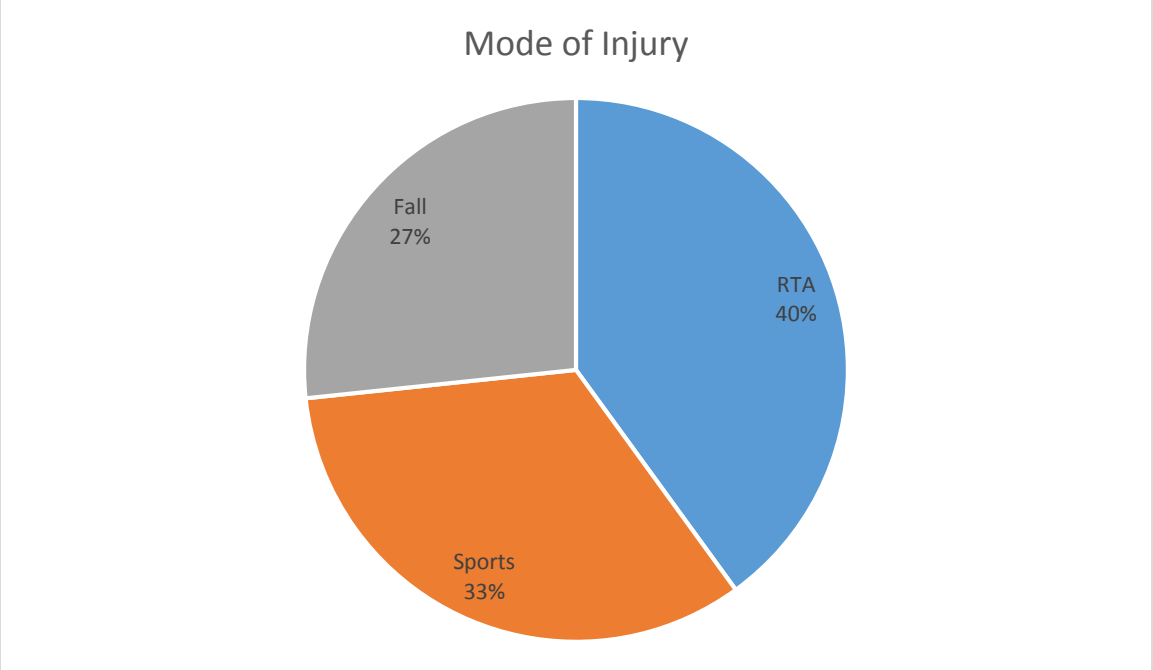
	Frequency	Percent
Left	7	47
Right	8	53
Total	15	100



Right knee was injured in 8 patients (53%) and left knee was injured in 7 patients (47%).

Distribution of cases based on mode on injury

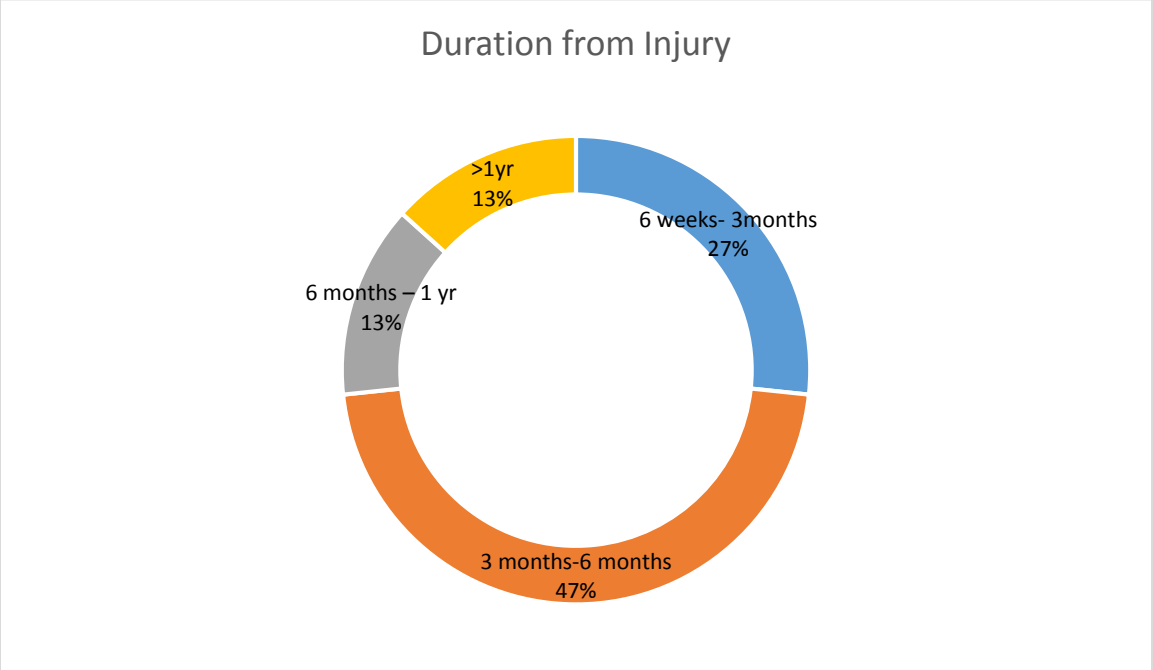
	Frequency	Percent
RTA	6	40
Sports	5	33
Fall	4	27



Most of the ACL tears were caused by RTA (40%). Next common cause was sports activities like kabadi. Some patients (27%) got injured while doing daily activities like slip and fall while walking/ climbing down stairs.

Distribution of cases based on Duration from injury

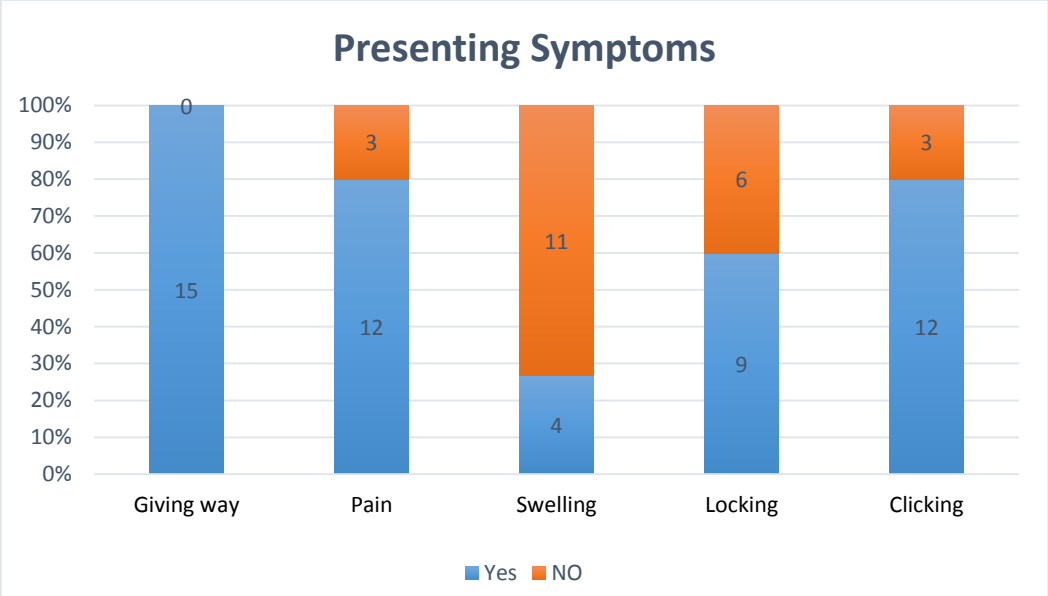
Duration	Frequency	Percent
6 weeks- 3months	4	27
3 months-6 months	7	47
6 months – 1 yr	2	13
>1yr	2	13
Total	15	100



Majority of the patients who were operated had a time interval from injury to surgery between 3months – 6 months (47%) followed by 6weeks- 3 months (27).

Distribution of cases based on symptoms at presentation

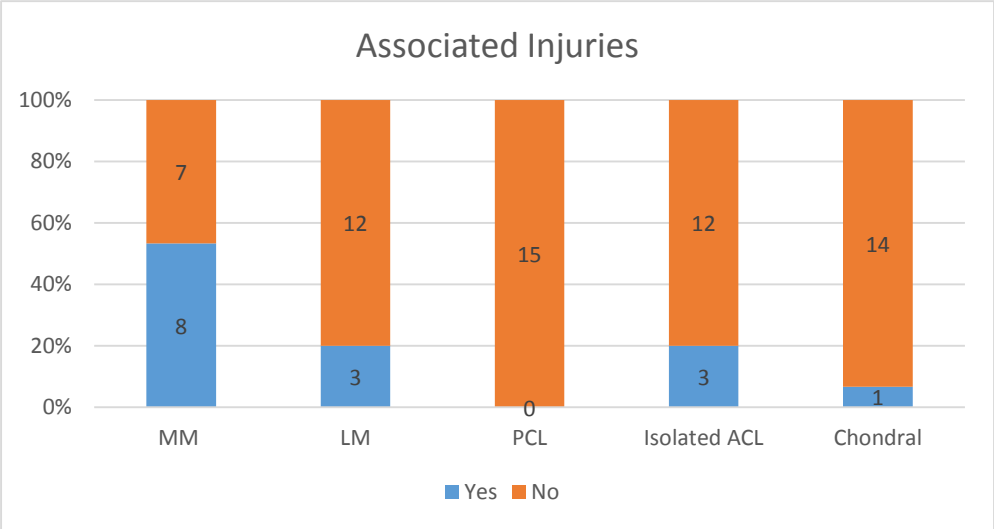
	Frequency	Percent
Giving way	15	100
Pain	12	80
Swelling	4	27
Locking	9	60
Clicking	12	80



All patients presented with complaints of giving way of the knee. 80% of the patients were able to appreciate the clicking of knee. 27% cases were having swelling and 80% cases presented with complaint of pain. 60% gave history of locking of knee which was correlated with associated injuries in the knee.

Distribution of cases based on associated injuries

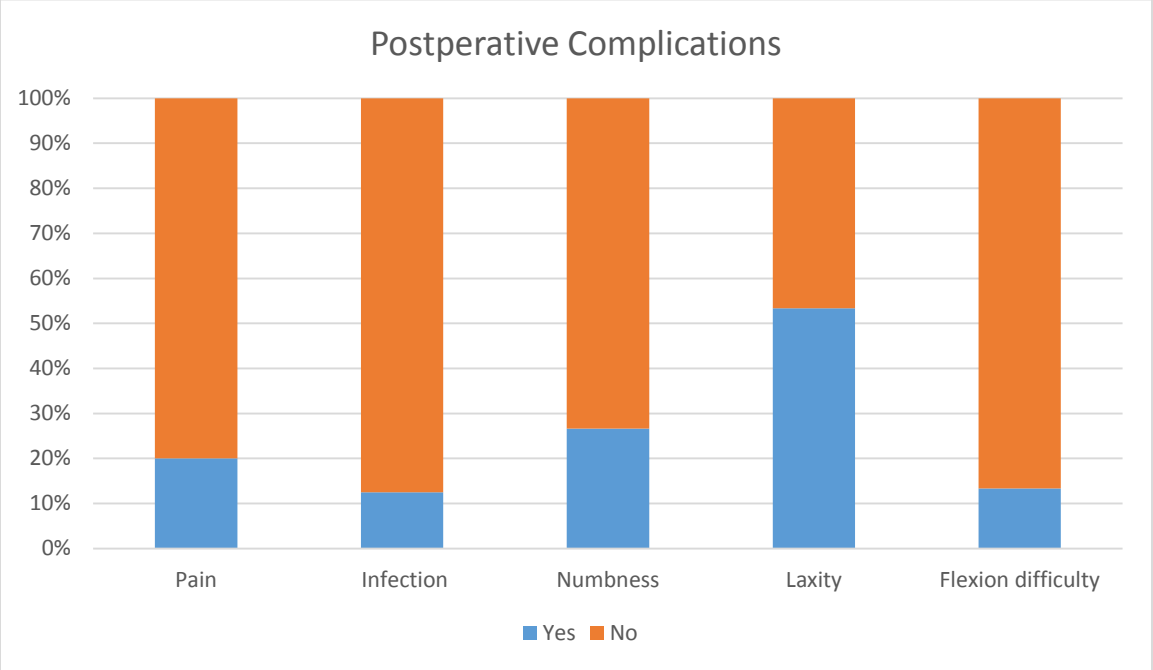
	Frequency	Percent
MM	8	53
LM	3	20
PCL	0	0
Isolated ACL	3	20
Chondral	1	7



Diagnostic arthroscopy prior to ACL reconstruction confirms the medial meniscal tear in 53% cases and 20% lateral meniscal tear. 20% were isolated ACL injuries. Only one case had osteochondritis dissecans. There was no PCL injury in our study.

Distribution of cases based on Postoperative complications

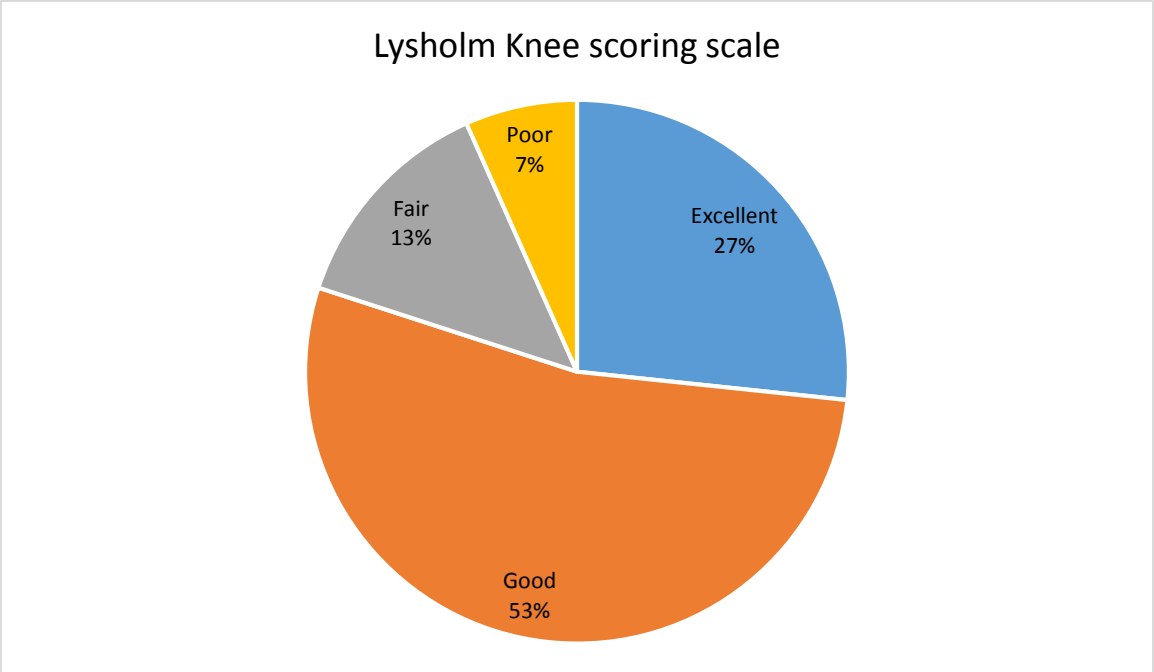
	Frequency	Percentage
Pain	3	20
Infection	2	13
Numbness	4	27
Laxity	8	53
Flexion difficulty	2	13



3 patients (20%) had pain at the graft site at the end of 6 months. Infection was present in 2 cases (13%) of which one case developed septic arthritis immediate postoperative period and another patient developed infection at endobutton site after 3 months postoperative. Majority of the patients (53%) were having grade I laxity at the end of 6 months but with hard end point. 2 patient (13%) had flexion difficulty beyond 60 degrees due to noncompliant physiotherapy.

Distribution of cases based on Postoperative Lysholm scoring

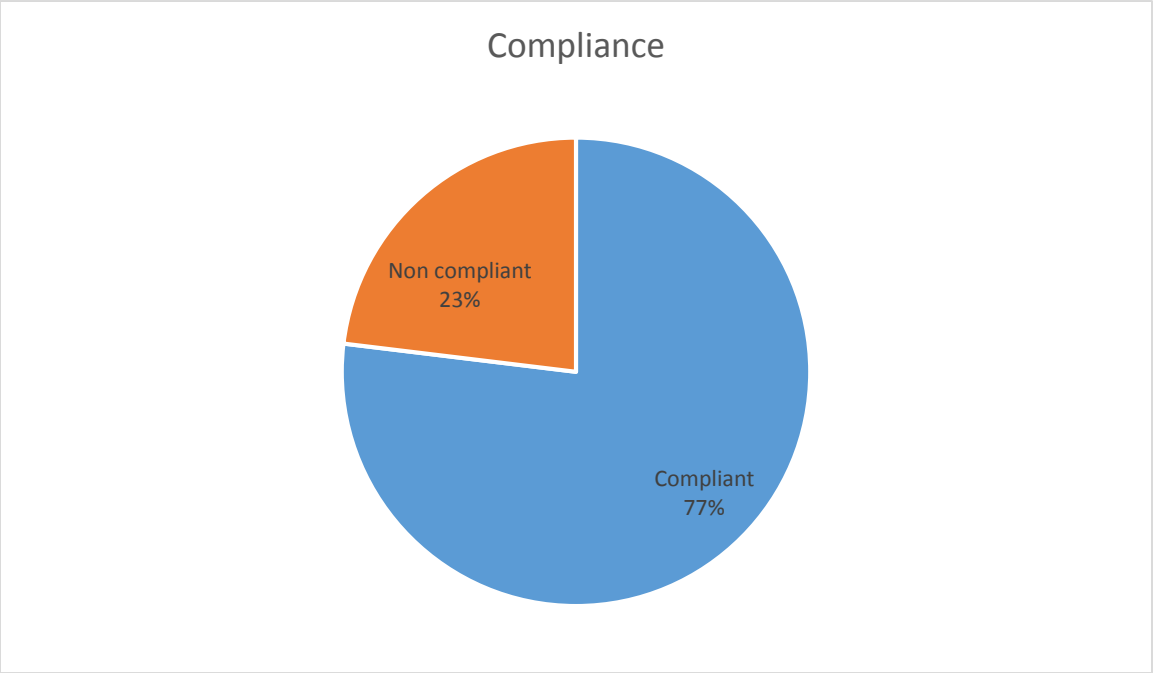
	Frequency	Percent
Excellent	4	27
Good	8	53
Fair	2	13
Poor	1	7



Around 80% of the patients reported outcome as excellent and good with scores above 95 and 84-94 respectively. 2 patients (13%) scored >65 & <83 and were grouped as fair outcome. One patient had poor outcome

Distribution of cases based on Physiotherapy compliance

	Frequency	Percent
Compliant	10	77
Non -compliant	5	23

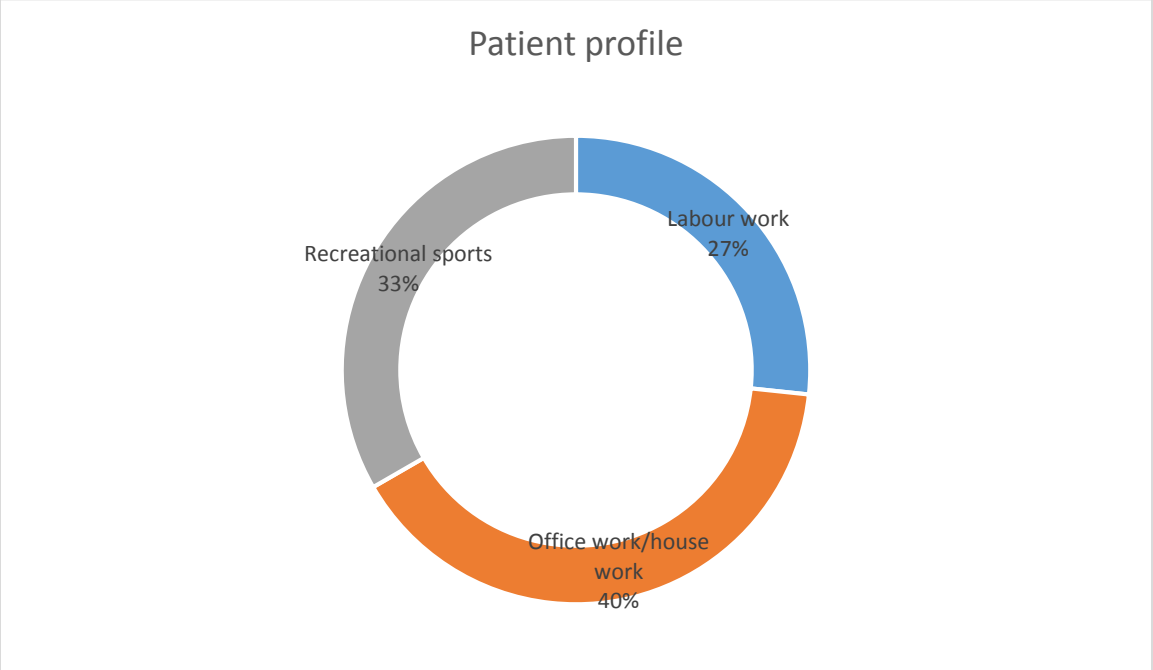


77% of patients were compliant to postoperative rehabilitation protocol and 23% were

Non- compliant

Distribution of cases based on patient profile

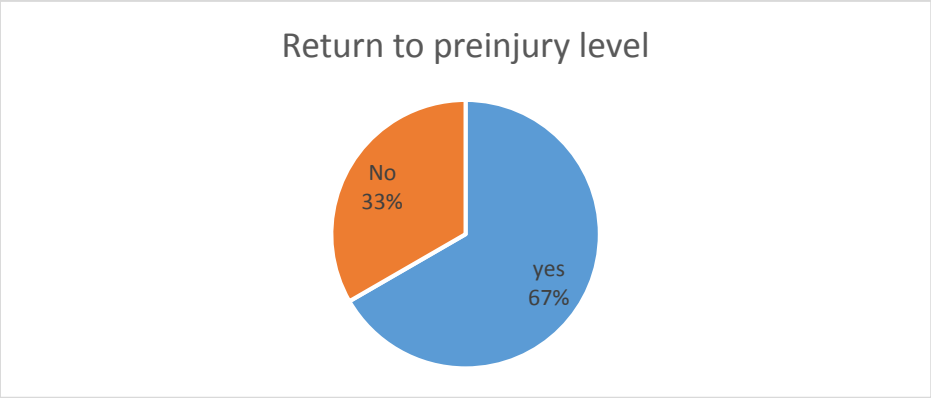
	Frequency	Percent
Labour work	4	27
Office work/house work	6	40
Recreational sports	5	33
Total	15	15



40% of patients were involved in light office/house work, 33% were recreational sports persons and 27 % were labour workers.

Distribution of cases based on pre-injury activity level

	Frequency	Percent
Return to pre-injury level	10	67
Not return to pre-injury level	5	33



67% of patients were able to return to pre-injury level and 33% did not return to pre-injury level.

Case Illustrations

Case 1: Nagraj, 29/m, ACL tear-Right, Lysholm score 95 (Excellent)

Pre-op- MRI

Post op X Ray – AP view

Post Op X Ray – Lateral view

Post Op Flexion

Post op Extension

Post op Squatting

Case 2: Prabhakaran, 27/m, ACL with Lateral meniscus tear-Right, Lysholm score 95 (excellent)

Pre- op MRI

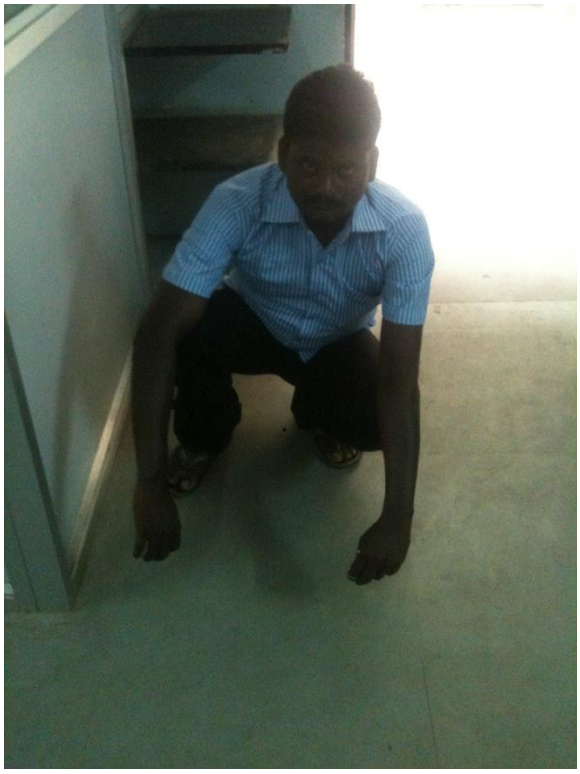
Post Op Xray – AP view

Post Op Xray Lateral view

Post Op Flexion

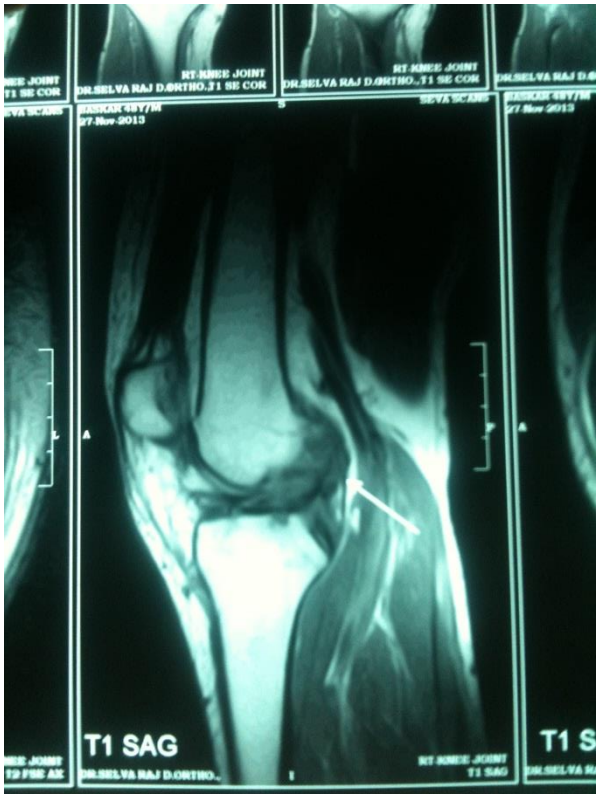
Post Op Extension

Post Op Squatting



Case 3: Baskar 40/m, ACL with medial meniscus tear-Right, Lysholm score 95(Excellent)

Pre op MRI



Post Op X Ray – AP view

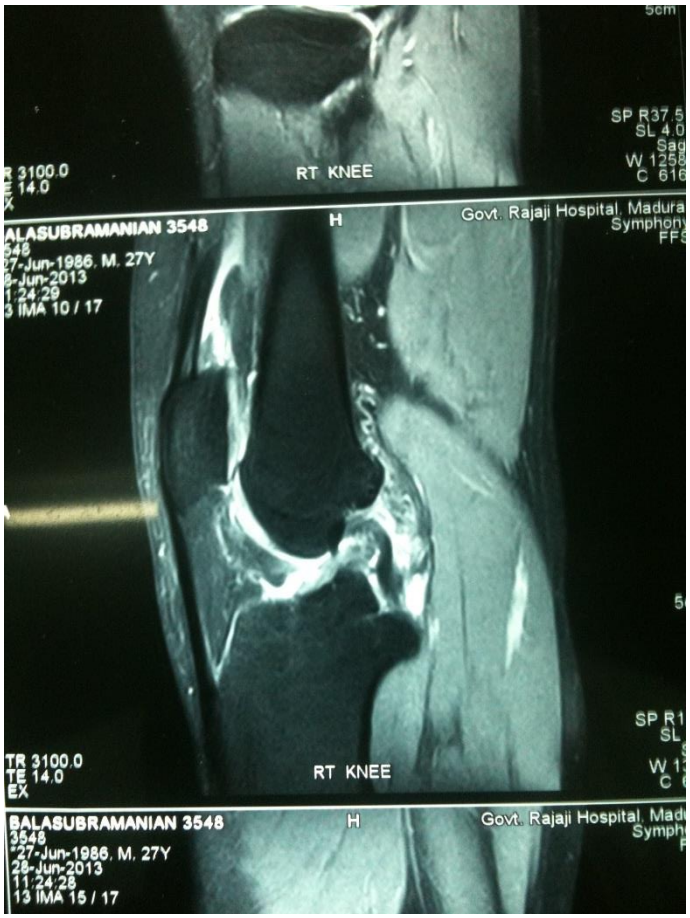
Post Op XRay- lateral view

Post Op Flexion

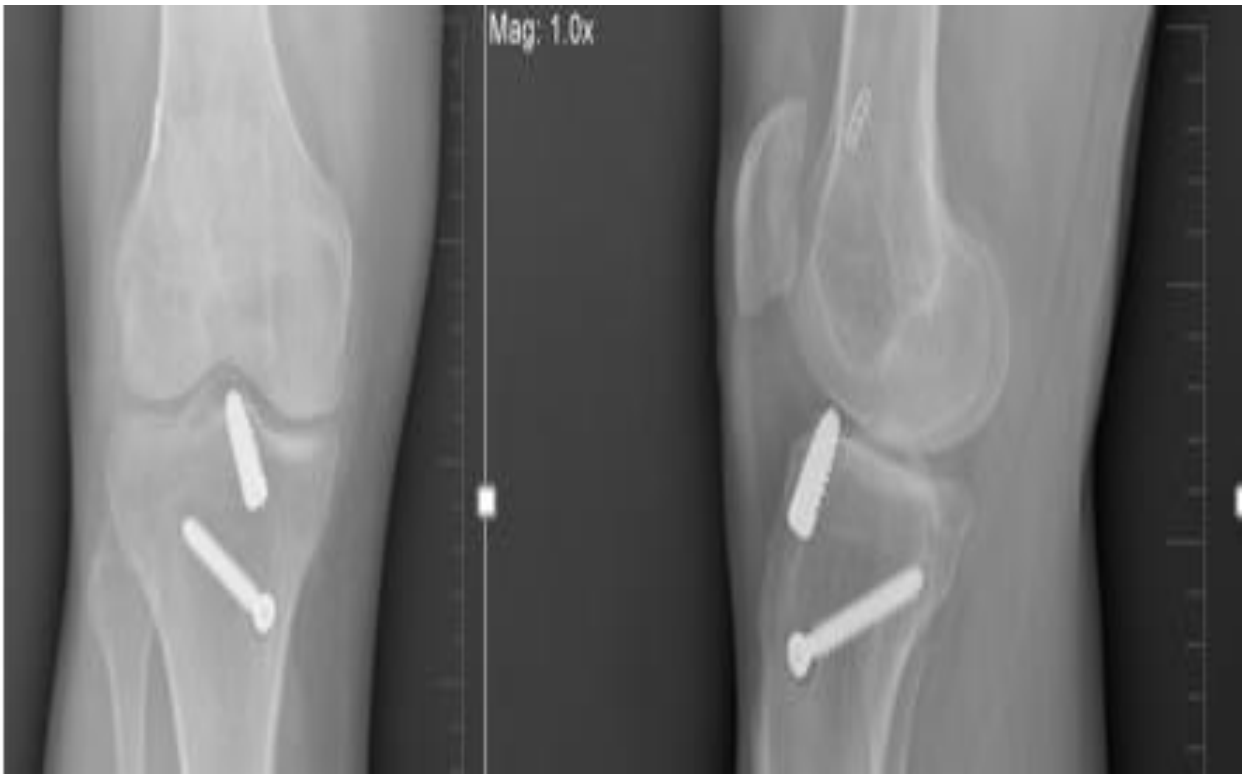
Post Op Extension

Case 4: Balasubramaniam, 27/m, ACL with medial meniscus tear-Right, Lysholm score 95 (Good)

Pre op MRI



Post op X Ray



Post Op flexion

Post op Extension

Post op Squatting

Case 5: Pandiammal, 40/f, ACL with medial meniscus tear-Left, Lysholm score 90 (Good)

Pre op MRI

Post Op X Ray – AP view

Post Op X Ray Lateral view

Post Op Flexion

Post op Extension

Discussion

ACL tear if not treated leads to knee disability, which can become severe and devastating long term consequences. With improving surgical techniques, results and favorable outcomes, patient and physician expectations are evolving to include the expectancy of return to activities and sports at normal or near normal levels.

In-spite on many graft choices for ACLR, hamstring autografts have gained popularity in the past decade. Several studies proved that 4 strand hamstring tendon ACLR have better strength, stiffness, and cross-sectional area compared with patellar tendon grafts.

Hamstring tendon autograft harvest site yields less donor site morbidity than BPTB graft and also has no risk of patellar fracture. Technical factors, specifically the absence of adequate fixation techniques, initially limited the use of hamstring grafts for ACL reconstruction. New techniques using Endobuttion, cross pin fixation focus on optimizing graft strength and stiffness.

The success of ACLR using hamstring autograft needs stable initial graft fixation and, ultimately, graft- to- bone healing. Hamstring reconstruction using femoral endobutton fixation has shown to have excellent initial mechanical properties, including pullout strength.

In our study all the 15 patients underwent ACL reconstruction using hamstring autograft during the study period in Government Rajaji Hospital, Madurai. The patients underwent graft fixation using endobutton in the femoral tunnel and intereference screw fixation in tibial tunnel with

suture disc or anchoring screw with a washer if necessary. Arthroscopic ACL reconstruction was done as an in-patient procedure in all patients under spinal anaesthesia.

12 (80%) were male patients and 3 female patients (20%), all aged between 20 and 40 years of age. The side of injury was distributed accordingly – 53% [8 patients] to right knee while 47% [7 patients] injured their left knee. Brown et al [67] studied the incidence of sex and limb differences in anterior cruciate ligament injury and stated that even though females are prone for injury, due their less exposure to strenuous environment makes the incidence of males more than females. They also concluded that limb differences have no influence either during injury or in the recovery period.

Majority of our patients (40%) are office goers/house workers, followed by recreational sports people (33%) and the rest (27%) are labor workers. Once the day to day activities of walking, squatting and climbing stairs returned, after following patients according to rehabilitation protocol for 6 months during immediate postoperative and follow up period, it was observed that adherence to physiotherapy gradually waned in most of the patients. 77% were compliant for physiotherapy.

Vassilios S Nikolaou et al, in June 2008, after a retrospective analysis of MRI efficiency in diagnosing internal lesions of the knee, reported that the accuracy for tears to the medial, lateral meniscus, ACL, PCL and articular cartilage was 81%, 77%, 86%, 98% and 60% respectively [68]. The clinical examination reliability was less when compared to MRI in the detection of

these injuries and concluded that MRI aids in diagnosing soft tissue injuries of the knee. The arthroscopy still remains the gold standard for definitive diagnosis.

In the Lysholm knee scoring scale 27% of the patients reported outcome as excellent, 53% good, 13% fair and 7% poor. In Bourke et al [69] a total of 143 patients (94%) had a good or excellent Lysholm score at one year and 134 (88%) had good or excellent scores at 15 years.

In our study 67% of patients returned to pre-injury level and 33% did not return to pre-injury level.

Conclusion

Anterior cruciate ligament injuries are common in younger age group individuals.

Males are more prone for ACL injuries.

Giving way of the knee is the main presenting symptom (100%) in our study

Medial meniscus was the commonest associated injury

All patients had instability of knee in the form of giving way evaluated by Lachman test and confirmed by arthroscopy.

Arthroscopic anterior cruciate ligament reconstruction with hamstring graft is an excellent treatment option for anterior cruciate ligament injured knees.

Arthroscopic ACL reconstruction using hamstring autograft provides a stable knee with minimal complications.

ACLR reduces postoperative morbidity and enables early rehabilitation

The functional outcome of anterior cruciate ligament reconstruction with quadrupled hamstring autograft is excellent to good (80%) with mild laxity at the end of 6 months.

67% of the patients were able to return to pre injury level of activity.

Annexure 1: LYSHOLM Knee scoring scale

LYSHOLM KNEE SCORING SCALE

Instructions: Below are common complaints which people frequently have with their knee problems. Please check the statement which best describes your condition.

I. LIMP:
____ I have no limp when I walk. (5)
____ I have a slight or periodical limp when I walk. (3)
____ I have a severe and constant limp when I walk. (0)

II. USING CANE OR CRUTCHES
____ I do not use a cane or crutches. (5)
____ I use a cane or crutches with some weight-bearing. (2)
____ Putting weight on my hurt leg is impossible. (0)

III. LOCKING SENSATION IN THE KNEE
____ I have no locking and no catching sensations in my knee. (15)
____ I have catching sensation but no locking sensation in my knee. (10)
____ My knee locks occasionally. (6)
____ My knee locks frequently. (2)
____ My knee feels locked at this moment. (0)

IV. GIVING WAY SENSATION FROM THE KNEE
____ My knee never gives way. (25)
____ My knee rarely gives way, only during athletics or other vigorous activities. (20)
____ My knee frequently gives way during athletics or other vigorous activities, in turn I am unable to participate in these activities. (15)
____ My knee occasionally gives way during daily activities. (10)
____ My knee often gives way during daily activities. (5)
____ My knee gives way every step I take. (0)

V. PAIN:
____ I have no pain in my knee. (25)
____ I have intermittent or slight pain in my knee during vigorous activities. (20)
____ I have marked pain in my knee during vigorous activities. (15)
____ I have marked pain in my knee during or after walking more than 1 mile. (10)
____ I have marked pain in my knee during or after walking less than 1 mile. (5)
____ I have constant pain in my knee. (0)

VI. SWELLING
____ I have no swelling in my knee. (10)
____ I have swelling in my knee only after vigorous activities. (6)
____ I have swelling in my knee after ordinary activities. (2)
____ I have swelling constantly in my knee. (0)

VII. CLIMBING STAIRS:
____ I have no problems climbing stairs. (10)
____ I have slight problems climbing stairs. (6)
____ I can climb stairs only one at a time. (2)
____ Climbing stairs is impossible for me. (0)

VIII. SQUATTING
____ I have no problems squatting. (5)
____ I have slight problems squatting. (4)
____ I can not squat beyond a 90 degree bend in my knee. (2)
____ Squatting is impossible because of my knee. (0)

TOTAL____/100

Excellent - 95 – 100 points
Good - 84 – 94 points
Fair - 65 – 83 points
Poor - 64 or fewer points

Annexure 2: Proforma

PATIENT DETAILS

NAME		UNIT	
AGE		IP NO:	
SEX		DATE OF ADMN	
DATE OF SURGERY		DATE OF DIS	
ADDRESS :			
CONTACT NUMBER			
DIAGNOSIS			

METHODS

Clinical assessment

Lachman test

Anterior Drawer test

Pivot shift test

Lysholm knee score

Imaging

X rays- plain AP and Lateral view, MRI

Patient position: Supine position with operating leg in flexed position

Anaesthesia

Spinal Anaesthesia/ general anaesthesia

Implants

Endobutton 15,20,25 mm loop
Intereference screw 8,9,10 *25mm stainless steel/Titanium

Postoperative follow up

Immediate post op

6 weeks

Third month

Sixth month

One year

Postoperative Clinical Examination

Test	3months	6 months
Lachman		
Anterior Drawer		
Pivot shift		

Range of motion

ROM	6 weeks	3 months	6 months
Flexion			
Extension			
Extension lag			

Annexure 3: Consent

Model of Consent form to be obtained from the patients

I _____ Hosp. No._____ in my full senses

Here by give my complete consent for _____ or any other procedure deemed fit which is a diagnostic procedure / biopsy / transfusion / operation to be performed on me / my son / my daughter / my ward _____ age _____ under any anaesthesia deemed fit.

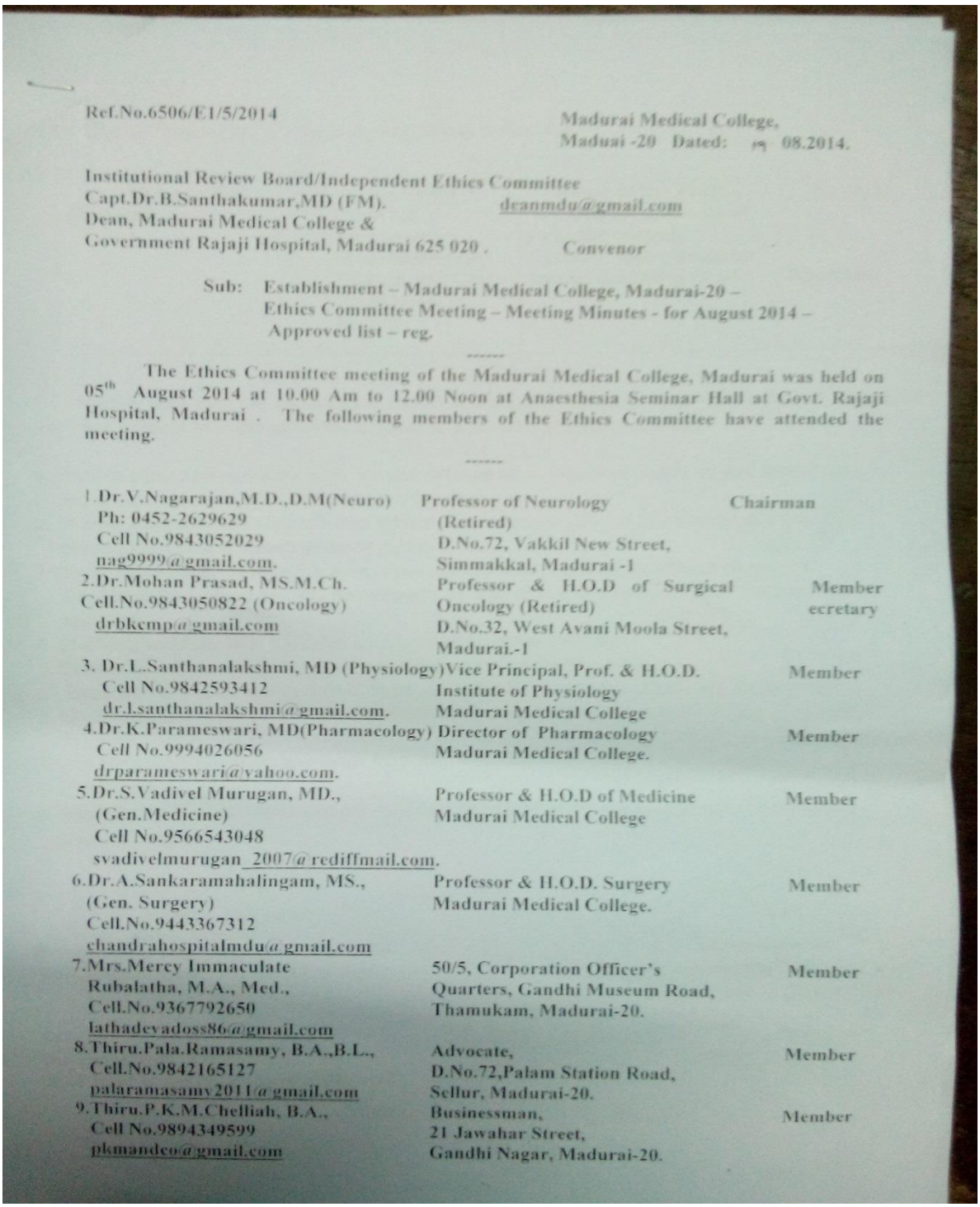
The nature and risks involved in the procedure have been explained to me to my satisfaction.

For academic and scientific purpose the operation/procedure may be televised or photographed.

Date :

Signature/Thumb Impression of Patient/Guardian

Annexure 4: Ethical Committee approval copy



Ref.No.6506/E1/5/2014

Madurai Medical College,
Maduai -20 Dated: 09.08.2014.

Institutional Review Board/Independent Ethics Committee
Capt.Dr.B.Santhakumar,MD (FM). deanmdu@gmail.com
Dean, Madurai Medical College &
Government Rajaji Hospital, Madurai 625 020 . Convenor

Sub: Establishment – Madurai Medical College, Madurai-20 –
Ethics Committee Meeting – Meeting Minutes - for August 2014 –
Approved list – reg.

The Ethics Committee meeting of the Madurai Medical College, Madurai was held on 05th August 2014 at 10.00 Am to 12.00 Noon at Anaesthesia Seminar Hall at Govt. Rajaji Hospital, Madurai . The following members of the Ethics Committee have attended the meeting.

1.Dr.V.Nagarajan,M.D.,D.M(Neuro) Ph: 0452-2629629 Cell No.9843052029 nag9999@gmail.com.	Professor of Neurology (Retired) D.No.72, Vakkil New Street, Simmakkal, Madurai -1	Chairman
2.Dr.Mohan Prasad, MS.M.Ch. Cell.No.9843050822 (Oncology) drbkcmp@gmail.com	Professor & H.O.D of Surgical Oncology (Retired) D.No.32, West Avani Moola Street, Madurai.-1	Member ecretary
3. Dr.L.Santhanalakshmi, MD (Physiology) Cell No.9842593412 dr.l.santhanalakshmi@gmail.com.	Vice Principal, Prof. & H.O.D. Institute of Physiology Madurai Medical College	Member
4.Dr.K.Parameswari, MD(Pharmacology) Cell No.9994026056 drparameswari@yahoo.com.	Director of Pharmacology Madurai Medical College.	Member
5.Dr.S.Vadivel Murugan, MD., (Gen.Medicine) Cell No.9566543048 svadivelmurugan_2007@rediffmail.com.	Professor & H.O.D of Medicine Madurai Medical College	Member
6.Dr.A.Sankaramahalingam, MS., (Gen. Surgery) Cell.No.9443367312 chandrahospitalmdu@gmail.com	Professor & H.O.D. Surgery Madurai Medical College.	Member
7.Mrs.Mercy Immaculate Rubalatha, M.A., Med., Cell.No.9367792650 lathadevadoss86@gmail.com	50/5, Corporation Officer's Quarters, Gandhi Museum Road, Thamukam, Madurai-20.	Member
8.Thiru.Pala.Ramasamy, B.A.,B.L., Cell.No.9842165127 palaramasamy2011@gmail.com	Advocate, D.No.72,Palam Station Road, Sellur, Madurai-20.	Member
9.Thiru.P.K.M.Chelliah, B.A., Cell No.9894349599 pkmandco@gmail.com	Businessman, 21 Jawahar Street, Gandhi Nagar, Madurai-20.	Member

The following Project was approved by the Ethical Committee

Name of P.G.	Course	Name of the Project	Remarks
Dr.Karthik.A	PG in MS (Orthopaedic) Madurai Medical College, and Govt. Rajaji Hospital, Madurai	A study on outcome of Anterior cruciate ligament reconstruction using Hamstring Graft	Approved

Please note that the investigator should adhere the following: She/He should get a detailed informed consent from the patients/participants and maintain it Confidentially.

1. She/He should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution or to Government.
2. She/He should inform the institution Ethical Committee, in case of any change of study procedure, site and investigation or guide.
3. She/He should not deviate the area of the work for which applied for Ethical clearance. She/He should inform the IEC immediately, in case of any adverse events or Serious adverse reactions.
4. She/He should abide to the rules and regulations of the institution.
5. She/He should complete the work within the specific period and if any Extension of time is required He/She should apply for permission again and do the work.
6. She/He should submit the summary of the work to the Ethical Committee on Completion of the work.
7. She/He should not claim any funds from the institution while doing the work or on completion.
8. She/He should understand that the members of IEC have the right to monitor the work with prior intimation.

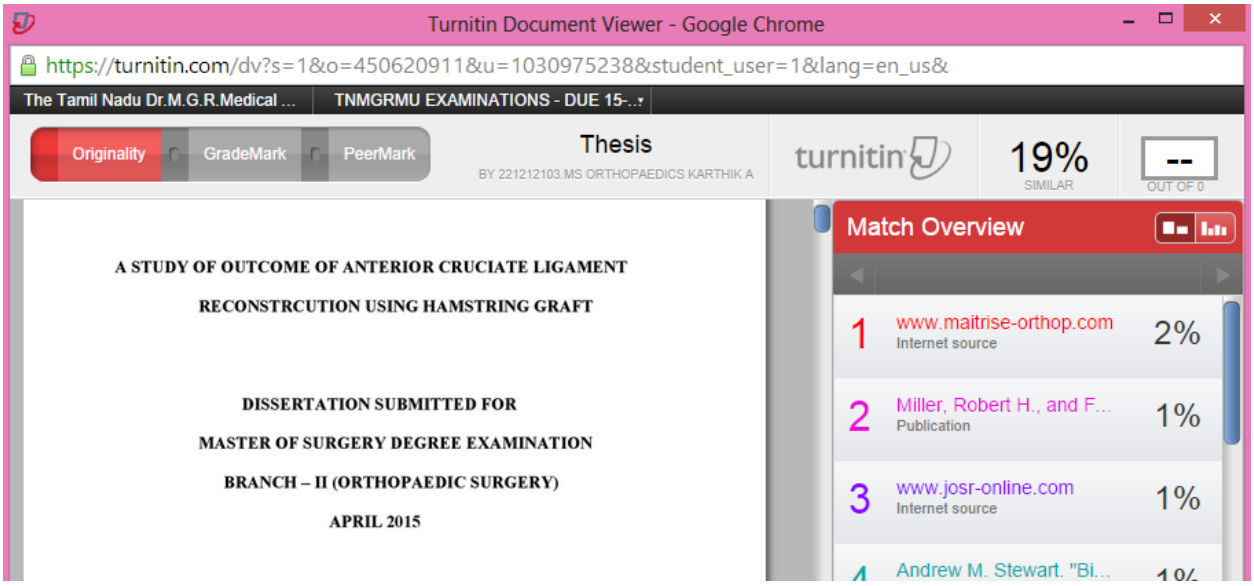
Member Secretary
Ethical Committee

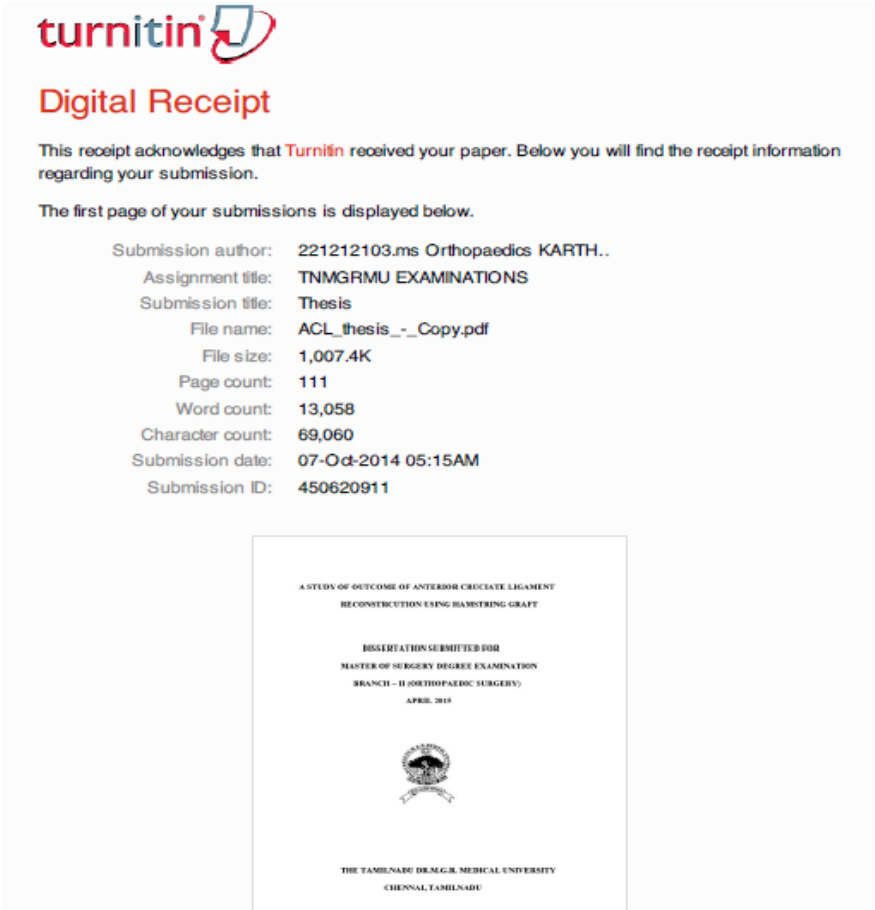
Chairman
Ethical Committee

19.6.14
DEAN/Convenor
Madurai Medical College & Govt.
Rajaji Hospital, Madurai- 20.

To
The above Applicant
-thro. Head of the Department concerned

Annexure 5: Plagiarism certificate





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List of Abbreviations

ACL	Anterior Cruciate Ligament
ACLR	Anterior Cruciate Ligament Reconstruction
BPTB	Bone patella bone tendon
F	Female
M	Male
L	Left
R	Right
RTA	Road traffic accident
MM	Medial meniscus
LM	Lateral meniscus
MMT	Medial meniscus tear
LMT	Lateral meniscus tear
PCL	Posterior cruciate ligament
PMM	Partial medial meniscectomy
PLM	Partial lateral meniscectomy
mo	months
IKDC	International knee documentation committee
yr	year
RCI	Round cannulated interference screw
OA	osteoarthritis
mm	millimeter

MASTER CHART

S.No	Age	sex	Side	MOI	DOI	Associated injuries	Procedure	Lysholm score		Outcome	Followup	Complications
								Preop	Postop-6 mon			
1	22	M	L	kabadi	3mo	None	ACLR	54	90	Excellent	1yr,3mo	
2	30	F	L	Fall	6mo	none	ACLR	40	76	Fair	1yr,3mo	Tibial screw removal
3	29	M	R	kabadi	2yr	MMT	ACLR+PMM	57	85	Good	1yr,1mo	
4	27	M	R	kabadi	2yr	MMT	ACLR+PMM	57	95	Excellent	1 yr	
5	25	M	R	RTA	1yr	MMT	ACLR+PMM	46	81	Fair	9 mo	Infection, stiff knee
6	35	M	R	Fall	3mo	MMT	ACLR+PMM	40	85	Good	9mo	
7	30	M	L	RTA	3mo	none	ACLR	46	53	Poor	8mo	Infection
8	27	M	R	kabadi	2mo	LMT	ACLR+PLM	54	95	Excellent	9mo	
9	40	F	L	Fall	1yr	MMT	ACLR+PMM	53	90	Good	8mo	
10	40	M	R	RTA	4mo	MMT	ACLR+PMM	57	95	Excellent	7mo	
11	29	M	R	kabadi	6mo	MCL	ACLR	53	95	Excellent	6mo	
12	27	M	R	RTA	4mo	Osteochondritis dissecans	ACLR+	54	90	Good	6mo	Stiff knee
13	24	M	L	Fall	6mo	LMT	ACLR+PLM	53	91	Good	6mo	
14	29	M	L	RTA	6mo	MMT, LMT	ACLR+PMM +PLM	57	85	Good	6mo	
15	24	F	L	RTA	6mo	MMT	ACLR	40	85	Good	6mo	